USER PREFERENCES OF BICYCLE INFRASTRUCTURE

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LIST OF SYMBOLS AND ABBREVIATIONS

AASHTO	American Association of State Highway Transportation Oficials
ACS	American Community Survey
ORNL	Oak Ridge National Laboratory
NCHRP	National Cooperative Highway Research Program
NHTS	National Household Transportation Survey

SUMMARY

Cycling for transportation is experiencing a resurgence in much of the U.S. Consequently, this is becoming a hot topic of research, particularly when it comes to how we can make cycling safe. Still, most research studies bicyclists' travel behaviors and preferences in areas with strong bicycling cultures. This thesis discusses the findings of focus groups and a survey (N=1221) deployed in six communities in Alabama and Tennessee, where cycling is not (yet) popular and/or widely adopted, a setting that is much more representative of the nation at large. Three of these communities, considered *treatment sites*, were in the process of adding major cycling facilities to their transportation systems. The other three communities, which were paired up with a treatment site with similar land use and demographic characteristics, were considered *control sites*, as no such plans were on the immediate horizon, thus creating a setting for a quasi-experimental design. Focus groups were conducted in each of the treatment sites, highlighting a number of issues related to perceived safety and personal comfort in using the new proposed infrastructure. Not surprisingly, the types of infrastructure that limited interaction with automobile through, turning, and parking traffic were found to be perceived as more desirable among cyclists in areas where drivers (and potential cyclists) are not used to heavy cycling adoption. The quantitative analysis includes linear regression models built on respondents' reactions to images of bicycling infrastructure in terms of comfort, safety, and willingness to try, which confirmed preferences for more separated facilities and the deterrents introduced with adjacent parking. Results from this study provide useful insights

into ways to maximize the return on investments, and design bike infrastructure that can attract patronage and be most successful in areas lacking a substantial bicycling population.

CHAPTER 1. INTRODUCTION

1.1 Background

Transportation planning in the U.S. has traditionally been automobile-focused, resulting in marginalization of healthy and active modes of transportation like cycling and walking. This marginalization of active modes which has a substantial impact on to air pollution, dependence on international sources of fuel, and an alarming increase in obesity, heart disease and asthma among both adults and children (Sallis 2004). According to the National Household Travel Survey, 41% of all personal trips are three miles or less, a reasonable bicycling distance (Litman 2014). However, only about 1% of all trips made in the U.S. are by bike (AASHTO 2012). Given that about 36% of US adults are obese (Ogden et al. 2012) and that the transportation sector accounts for 28% of US greenhouse gases (ORNL 2011), planning agencies have come to recognize bicycling as an active mode of transportation that may have huge potential when incorporated as part of sustainable transportation planning. Despite the monetary investments required for interventions aimed at increasing cycling, the monetized social benefits in the form of fuel savings and health-care savings resulting from increased cycling activity can potentially outweigh the initial financial investments (Gotschi 2011).

The most commonly stated reason for not using cycling as a mode of travel is the perception of inadequate safety associated with it (AASHTO 2012; Klobucar and Fricker 2007; Akar and Clifton 2010). Major factors contributing to this perception are high speed limits, high traffic volumes, and the absence of dedicated facilities for cyclists that provide a physical separation from vehicular traffic (Dill and Carr 2003, Buehler and Pucher 2012).

Most importantly, facilities are often on isolated segments of streets and do not form a continuous network, thus failing to provide the perception of safe bicycling routes to destinations and undermining their own utility (Schoner and Levinson 2014).

While reasons to pursue cycling as a sustainable alternative and complement to vehicular transportation are well documented, accurate and robust data to support decisions on where and how to best develop new cycling infrastructure remain elusive. Regional surveys tend to have a very small sample of cyclists, since bicyclists constitute a marginal proportion of total traffic. There is also little data describing potential cyclists – who they are, the barriers that inhibit their cycling, and how infrastructure investments may help to overcome these barriers. As a result, we have little understanding of the latent demand from either current or potential cyclists who do not presently feel safe due to a lack of appropriate infrastructure. Cities with the intention of increasing cycling face two significant challenges: quantifying the effectiveness of interventions and justifying allocation of resources for cycling (Handy et al. 2014).

1.2 Study Objectives

The primary objective of this research is to understand the preferences for bicycle infrastructure and how these preferences can change. This thesis covers how preferences can change based on how both current and *potential* cyclists respond to different types of cycling infrastructure, thus facilitating a quantification of usage based on *route shifts* as well as a quantification of demand that includes both *induced trips and trips shifted to the cycling mode*.

To meet this objective, a comprehensive data collection and analysis process has been designed to improve the understanding of how people make choices about daily travel (in particular referring to the adoption, or lack thereof, of active modes of transportation), focusing on a region of the U.S. where a cycling culture is just emerging.

The research is intended to answer several key questions, including:

- What is the relative effectiveness of different types of bicycle facilities for attracting new bicycle users and increasing bicycle travel by existing bicycle users in different environments?
- What are the relative preferences of current and potential bicycle users for different types of bicycle facilities?
- How do such preferences vary by demographic characteristics, cyclist experience level, and community environments?

This study offers a unique opportunity to explore the factors affecting the travel behavior of different types of users, and the way in which new infrastructure projects affect the travel choices of residents in the affected areas, in particular regarding the adoption of cycling.

1.3 Selection of Communities

The choice of the specific areas of study was driven by the timelines of the new bike infrastructure projects, and the expected date of entry into service of the newly built infrastructure. Six neighborhoods (study areas) were included in the study. Three neighborhoods were defined as “treatment” neighborhoods, as each had plans for new bicycle infrastructure to open between Fall 2016 and Fall 2017, and three neighborhoods were defined as “control” neighborhoods, which had similar demographics and land use characteristics as the treatment neighborhoods but had no such plans to open bike infrastructure over the same timeframe. These areas were selected to facilitate the design of a full before and after study following the completion of the planned bicycle infrastructure. However, this thesis contains only the findings from the initial before study. Full findings including the before and after study are forthcoming.

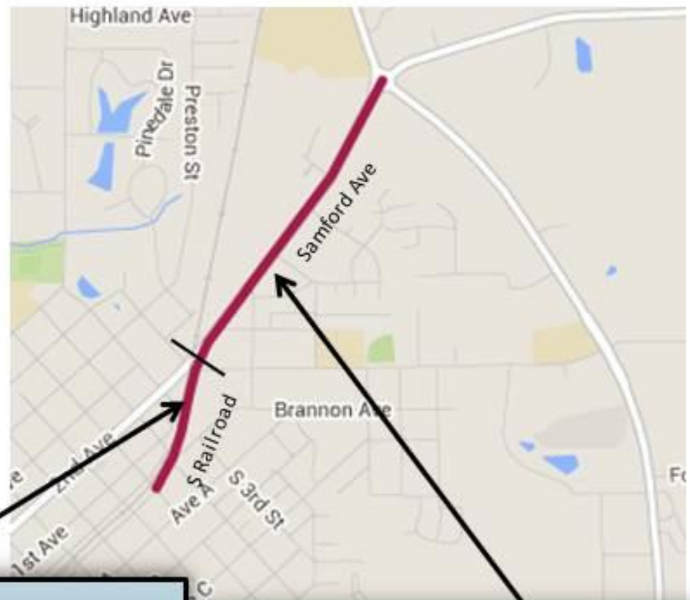
Study sites were selected from candidates in Alabama, Georgia, and Tennessee, where cycling for transportation is relatively new and rapidly expanding. This is in contrast to previous research on preference of bike facilities that has predominantly been conducted in communities where cycling is widely accepted and automobile drivers are conditioned to the presence of cyclists. The following pages provide detailed information on the three project sites identified for inclusion in the study, including demographics obtained from the American Community Survey (ACS) 2009 – 2013 data (5-year estimates). The three project sites include:

- Roadway diets in Opelika, Alabama
- Chattanooga, Tennessee protected bike lanes
- Anniston, Alabama bike plan

Opelika Roadway Diets

Opelika, AL

- **Opening April 2017**
- **Conversion of 4 lane to 3 lane with bike lanes**
  - ***Samford Ave - 0.73 mi***
- **Conversion of 3 lane to 2 lane with bike lanes**
  - ***S. Railroad - 0.36 mi***



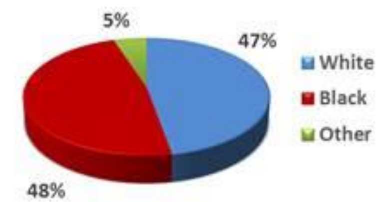
Data source: ACS 2009-2013

Tot. Pop.: 3,938 *(in 0.5 mile)*

0-17	18-34	35-50	51-65	>65
26%	22%	18%	20%	14%

Avg. HH Size: 2.45

Students: 5%



Hispanics: 2%

Renters: 48%

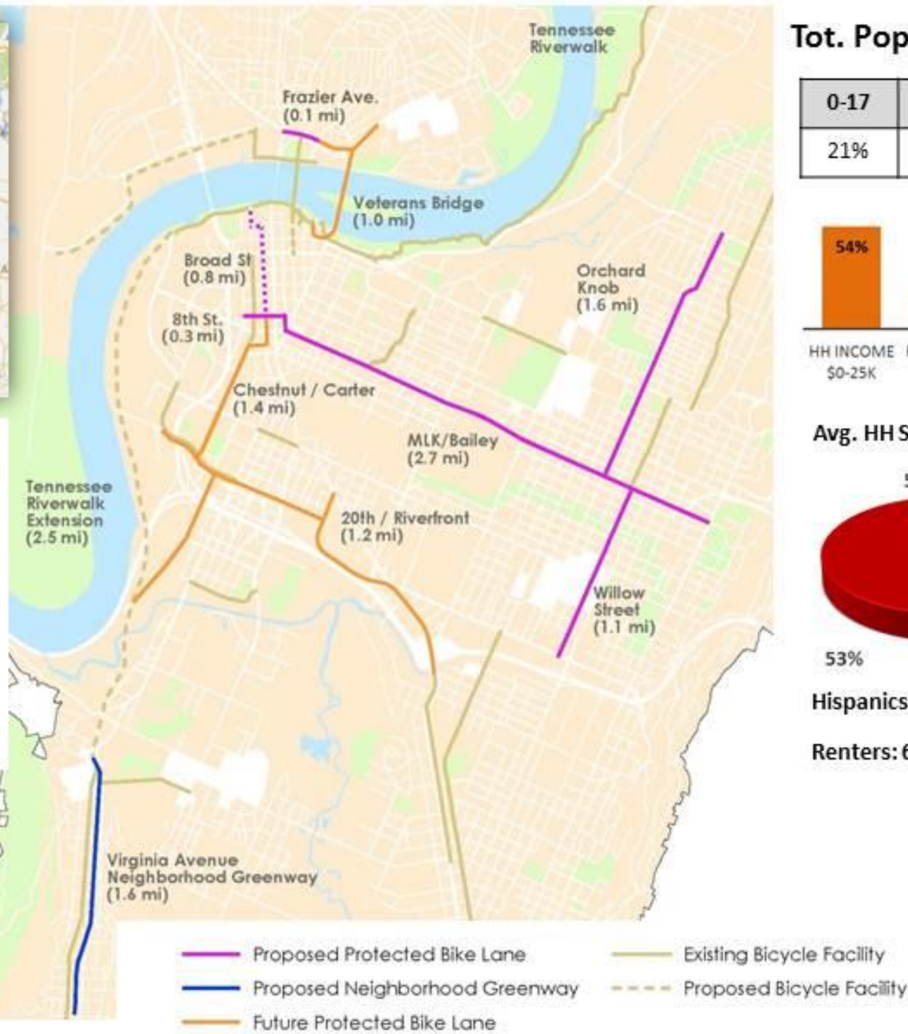
Walkscore: 37 – 60

Commute mode:
- **82.7% Drive alone**
- **9.5% Shared ride**
- **0.0% Public transit**
- **0.6% Bike**
- **1.4% Walk**
- **5.8% Other**

Chattanooga

Chattanooga, TN

- **Protected Bicycle Lanes**
  - **Opening summer 2017**
    - **MLK / Bailey**
    - **Willow St**
    - **Orchard Knob**
- **Additional adjacent projects**

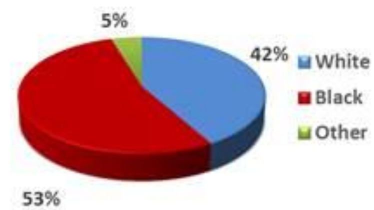


Data source: ACS 2009-2013

Tot. Pop.: 21,638 *(in 0.5 mile)*

0-17	18-34	35-50	51-65	>65
21%	35%	17%	17%	10%

Avg. HH Size: 2.72 **Students: 21%**



Hispanics: 5%

Walkscore*: *37 – 60

Renters: 62%

Commute mode:
- **61.8% Drive alone**
- **12.0% Shared ride**
- **4.1% Public transit**
- **2.7% Bike**
- **12.9% Walk**
- **6.6% Other**

Anniston Bike Plan

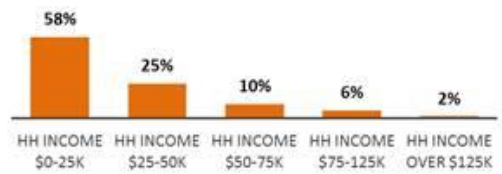
Anniston, AL

- **Bike lanes from Multimodal Transportation Center (MMTC) to Cold Mountain**
  - **Includes Noble Street and AL-202**
  - **Opening fall 2017**
- **Combination of Bike lanes and sharrows built along inner city loop in fall 2016**
- **Chief Ladiga Trail from MMTC to 15th St**
  - **Multimodal trail with unknown opening date**

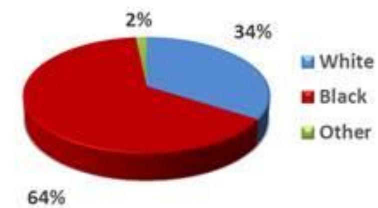
Data source: ACS 2009-2013

Tot. Pop.: 6,291 *(in 0.5 mile)*

0-17	18-34	35-50	51-65	>65
21%	23%	19%	22%	16%



Avg. HH Size: 2.51 **Students: 4%**



Hispanics: 2%

Renters: 50%

Walkscore*: *19 – 71

Commute mode:
- **79.0% Drive alone**
- **12.5% Shared ride**
- **0.7% Public transit**
- **0.0% Bike**
- **4.7% Walk**
- **3.1% Other**

Control neighborhoods were chosen so that each treatment neighborhood could be paired with a control neighborhood in terms of land-use and sociodemographic characteristics. Birmingham, AL was chosen as a control for Chattanooga, while Talladega, AL was chosen for a control for Anniston and Northport, AL for Opelika. The six study neighborhoods are shown in Figure 1, with comparison sociodemographic data presented in Table 1 and Table 2.

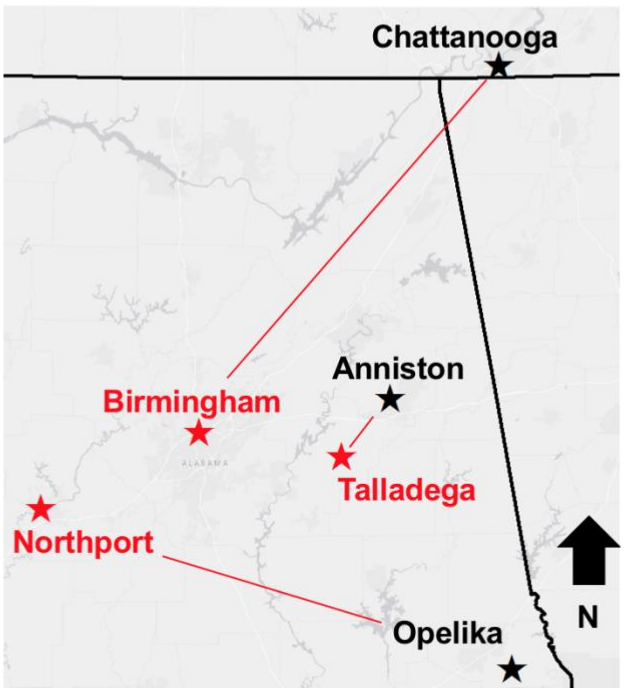


Figure 1 Map of treatment neighborhoods (black) and their control neighborhood pairs (red).

Table 1 Sociodemographics for Treatment and Control Neighborhoods

	Age				Race	
Site	18-35	35-50	50-65	65-85	White	Black
Anniston	29%	21%	30%	20%	36%	61%
Talladega	32%	25%	26%	17%	40%	57%
Opelika	30%	22%	28%	20%	45%	51%
Northport	40%	18%	21%	20%	56%	39%
Chattanooga	46%	21%	21%	12%	43%	52%
Birmingham	52%	19%	17%	11%	41%	53%
Combined	40%	21%	23%	16%	43%	52%

Table 2 Sociodemographics for Treatment and Control Neighborhoods

Site	Percent of Trips Nonmotorized	Mean Household Size	Population Density	Median Income	Population	Number of Households
Anniston	3%	2.49	1051	$28,029	11,204	4,494
Talladega	4%	3.04	994	$28,863	12,302	4,045
Opelika	2%	2.46	1411	$40,497	10,574	4,297
Northport	3%	2.41	1757	$35,363	10,077	4,189
Chattanooga	13%	2.83	3122	$28,824	22,469	7,927
Birmingham	13%	2.53	3081	$27,682	15,150	5,996
Combined	7%	2.64	2113	$30,998	81,776	30,947

1.4 Research Approach

The overall approach to understanding the relative preference for and relative effectiveness of various kinds of bicycle facilities among current and potential cyclists is cross-sectional and quasi-experimental, though this thesis only reports on the findings of the cross-sectional approach. The primary data source comes from stated preferences of potential and current cyclists through focus groups and a survey instrument. This approach provides a framework for estimating relative preferences for different variables for different segments of current and potential users. Key dependent variables include measures of perceived safety, comfort, and willingness to try biking on a bicycle facility, controlled for individual characteristics and infrastructure components, namely the type of bicycle facility, on-street parking, and the number of automobile lanes.

1.4.1 Focus Group Methods

The first method utilized in this research was the use of dedicated focus groups. Focus groups enable discussion and interaction with those within the communities of interest to gain a qualitative understanding of the motivators and barriers for adopting cycling in the community. The focus groups were intended to explore current and potential users' needs and preferences and to develop the survey instrument and tailor it to key issues in these communities.

1.4.2 Survey Data Collection Methods

The intent of the survey is (1) to identify the composition of the population of current and potential bicycle users, and their characteristics, (2) to assess the size of the persuadable market of potential bicycle users, (3) to assess preferences for "treatments", e.g. different types of bicycle infrastructure and facilities and (4) to investigate the impact of sociodemographic traits on the propensity to engage in bicycle use. Questions were designed to address all of these issues.

The survey was designed through an extensive process of writing, debating, and rewriting over a six-month period to select survey questions and refine their exact wording.

The goal was to produce a survey instrument that took approximately 30 minutes to complete. This allowed a nice balance of a thorough dataset, but limited time commitment from participants. To reduce potential response biases, the content of the survey was purposefully broader than just cycling to ensure that participants remain interested and do not quit the survey if they do not recognize themselves as the “biking type”. To the extent practical, questions were reused from previous surveys both to rely on previously tested and vetted questions and to maximize opportunities for cross-study comparisons of results. The resulting survey contains six sections, including:

A. Attitudes
B. Technology usage
C. Household location
D. Daily travel
E. Bicycling experience
F. Demographics

1.5 Outline of the Thesis

The following chapter includes a detailed review of the literature regarding user preferences of bicycle infrastructure. There is a plethora of findings regarding the preferences and behaviors of current cyclists and those in cities with a well-established culture of cycling. However, there is a significant gap regarding the preferences of those who do not currently cycle as well as those who reside in a community where cycling is not prevalent.

The remainder of the thesis reports and discusses the results derived from the aforementioned data sources. Chapter 3 assesses the qualitative results regarding the type of issues inhibiting cyclists among those who are interested but may not be active cyclists. Focus group participants raised issues related to perceived comfort and safety, particularly in their interactions with motor vehicles and a distrust of drivers in their communities.

Chapter 4 includes a description of the first wave survey (N=1223). It was found that each treatment site had similar observed characteristics to their respective control sites. Statistics segmented by rider type are also reported, which reveal distinct differences among observed characteristics among different rider types. Many of the questions raised from these statistics are addressed in the following chapter.

Chapter 5 contains the different analyses conducted on the first wave survey data. The analysis includes linear regression models on stated responses to different combinations of infrastructure characteristics, namely presence/absence of parking, two/four lanes, and different classes of bicycle facility (sharrows, bike lanes, buffered bike lanes, protected bike lanes, or multi-use paths).

The thesis concludes in Chapter 6, where major highlights from each chapter are summarized. The findings of the different methods are combined, and further steps are discussed, including additional sources of data and additional analyses to be undertaken.

CHAPTER 2. LITERATURE REVIEW

2.1 Research Design

Much of the current literature regarding bicycle demand is devoted to assessing the effectiveness of additional facilities on increasing cycling rates; however, there are substantial gaps in the literature to date. Many of these studies did not adequately explain their measures or methodology, did not use a treatment and control methodology, were not peer-reviewed, relied on samples from existing cyclists only, or biased the sample by stressing the focus on cycling at the outset (Pucher et al. 2010). This section includes an overview of research designs that have been undertaken in the topic of forecasting the effects of cycling infrastructure, along with their limitations.

Early studies in a new area of travel behavior research typically employ cross-sectional methods with a sample of the population at a single point in time to establish associations between observed behaviors and possible factors influencing such behavior (Krizek et al. 2009b). The first major study of this nature, Nelson and Allen (1997), evaluated data from 18 major U.S. cities, and built a basic linear regression model indicating a loose correlation between miles of bicycle infrastructure and cycling rates. Other aggregate-level studies followed suit in efforts to explain inconsistencies observed throughout different cities by increasing the number of cities and variables, with Dill and Carr (2003) using a similar regression model on data from 43 large U.S. cities, and Buehler and Pucher (2012) using data from 90 of the 100 most populous U.S. cities. Both of these studies confirm a correlation between infrastructure availability and bicycle commute mode share. However, cross-sectional aggregate studies reveal only correlation—not causality. Consequently, these studies fall short of adequately answering the question of whether cycling preceded infrastructure or vice versa.

Other studies have taken a disaggregate approach to identifying the effects of infrastructure. User's propensity to cycle is positively influenced by the presence of dedicated infrastructure (Moudon et al. 2005; Krizek and Johnson 2006; Handy and Xing 2011; Akar and Clifton 2010; dell'Olio et al. 2014; Stinson et al. 2014), as is the number of trips made by cyclists (Dill and Voros 2008; Stinson et al. 2014), though propensity and frequency should be modeled separately (Ma and Dill 2015). Xing et al. (2010) also found a correlation between the presence of infrastructure and the number of miles a cyclist will ride.

Time-based studies have been recommended by many to counteract the major flaw of cross-sectional studies in failing to identify time-based trends (Nelson and Allen 1997; Buehler and Pucher 2012; Dill and Carr 2003; Pucher et al. 2010). Repeated cross-sections have been conducted for major cities to measure bicycle commuting rates at two points in time (before and after infrastructure investments), with the hypothesis that the change in infrastructure availability will correlate with a change in cycling rates. Krizek et al. (2009a) used a repeated cross-section design with data from two consecutive decennial censuses to show that TAZs near new infrastructure showed increased cycling rates as compared to TAZs outside of the buffer zone. However, Cleaveland and Douma (2008) repeated similar methodology in six other major U.S. cities with varying effects. Parker et al. (2013) conducted an aggregated count-based study along a corridor in New Orleans before and after the implementation of a bike lane with two parallel control streets, showing that more users biked along the corridor after implementation. Some of the new users diverted from the control streets, though the scale was not large enough to truly assess the changes throughout the neighborhood.

Although repeated cross-sections are an improvement over the basic cross-sectional design, they still only allow for a limited temporal perspective, resulting in a need for experimental and quasi-experimental studies. Such studies employ surveys at two or more points in time to measure changes in preferences or behavior individually, as opposed to measuring two aggregate measures. In a truly experimental survey design, a sample of the population is randomly assigned to the treatment and control groups and intervention is administered to the treatment group. Any significant difference in outcome for the two groups are evidence of a causal relationship between the intervention and the outcome. However, as Krizek et al. (2009b) point out, when studying the effect of bicycle infrastructure on bicycle ridership, it is not possible to randomly grant members of the population access to the intervention, as would be required in a true experimental design. Instead, quasi-experimental methods may be used where behavior of people in the community is measured before and after the intervention, controlling for factors other than the intervention that may influence the behavior. This behavior is then compared with behavior of residents from a community without a similar intervention, with all other measurable variables being as similar as possible.

Quasi-experimental research designs on this topic have been conducted sparsely. Heinen et al. (2015) conducted a four-year quasi-experimental panel study for commuters living near a multi-use path in England. This study found that commuters are likely to begin using nearby additional biking infrastructure for trips they already make. Although this disaggregate study was able to quantify use of the new facility, there was no control for users diverting from existing infrastructure, so it could explain only the overall trends in the neighborhood, without being able to separate the infrastructure effects from any other environmental effects. Sahlqvist et al. (2015) similarly conducted a panel survey for residents near multi-use paths in cities throughout the United Kingdom. They found that measures related to positive perceptions of walking and biking generally improved after the implementation of new infrastructure, though they lacked an analysis to describe differences in preferences. Rissell et al. (2015) performed a similar study in Australia, which used bike counts in addition to survey data, finding that bike counts after the treatment increased. However, the self-reported cycling rates did not change significantly, likely due to redirecting routes or by increased usage from individuals outside the study area. From these studies, it is clear that there is a need for more extensive studies of the quasi-experimental nature with the specific purpose of analyzing the effects of infrastructure on propensity to cycle, while using existing research as a basis of modeling parameters.

2.2 Data Sources

One challenge in determining the causal effect of infrastructure on bicycling behavior is the number of possible confounding variables, which requires collecting accurate data on many covariates, particularly from non-bicyclists. This section includes a summary of necessary data sources and potential collection methods.

Researchers have typically used surveys as the primary data collection instrument for panel studies. Intercept surveys can be used to collect data from bicyclists (Thakuriah et al. 2012), though other methods would be necessary to capture non-cyclists. Xing and

Handy (2014) warn that the survey platform itself may influence the representativeness of the sample. In addition, Forsyth et al. (2010) point out that surveying a truly representative bicyclist sample is expensive, with many opting for surveys targeting cyclists, which may lead to results that are not representative of the population in general.

As mentioned previously, qualitative methods such as interviews and focus groups are critical to understanding infrastructure needs (Handy et al. 2014). These qualitative methods can support quantitative methods in important ways by suggesting new variables to be tested in a more rigorous quantitative methodology (Clifton and Handy 2003; Spencer et al. 2013). Focus groups can provide important insights into attitudes, perceptions, preconceptions and factors which might prompt changes in behavior. Variations in attitudes and behavior between rural, small town, suburban and urban settings can be difficult to understand without the more anecdotal and descriptive information obtained from focus group discussions.

Studies on recent increases in bicycling have included many different infrastructure treatments, programs, and policies. From a review of 139 separate studies, Handy et al. (2014) concluded that bike parking, integration with transit, cycling promotion programs, and combinations of multiple interventions have for the most part been associated with an increase in bicycling levels. Although the primary focus of this project is on the influence of cycling infrastructure on users' propensity to bike, the research design necessitates controlling for other known variables affecting cycling behavior to the extent possible.

Quantitative data is commonly obtained on the aggregate level from pre-existing sources such as the Census, American Community Survey (ACS), or National Household

Travel Survey (NHTS), which allows for large-scale studies comparing different geographic areas (Krizek et al. 2009b; Buehler and Pucher 2012; Cleaveland and Douma 2008; Dill and Carr 2003; Jones 2012; Schoner and Levinson 2014; Stinson et al. 2014; Parkin et al. 2008). These types of data sets have been used for cross-sectional and repeated cross-sectional designs, though they cannot be used to describe the changes of an individual based on treatment. Time-series data is difficult to collect, particularly on the disaggregate level, because it requires substantial, consistent data collection over a sustained period of time (Nelson and Allen 1997). However, this type of data is necessary for a quasi-experimental design and the associated implications of causality.

2.3 Types of Cycling Infrastructure

Studies of infrastructure treatments such as bicycle lanes, shared lanes, off-street paths, bicycle boulevards, cycletracks, bike boxes, traffic signal phases, traffic calming, car-free zones, and complete streets show that a significant increase in the number of bicyclists can be achieved by providing facilities for safe riding (Pucher et al. 2010).

As discussed by Handy et al. (2014), studies often measure infrastructure in simplistic terms such as miles of bicycle lanes or of all types of bicycle facilities without differentiation of facility type (e.g. Dill and Carr 2003; Krizek et al. 2009a; Cleaveland and Douma 2008; Schoner and Levinson 2014). Parker et al. (2013) found that implementation of a bike lane was effective in attracting bike trips to the corridor, while other studies have shown increased usage for on off-street bicycle and multi-use paths, though the magnitude differs in each case (Jones 2012; Heinen et al. 2015; Downward and Rasciute 2015; Rissel et al. 2015; Sahlqvist 2015).

Results regarding the relative impact on different infrastructure types are inconsistent. Buehler and Pucher (2012) find no significant difference between the effects of on-street bike lanes and off-street trails in cities throughout the United States, though both have a positive correlation with cycling. Hankey et al. (2012) found that off-street trails have a significantly greater impact on cycling than on-street lanes on the aggregate in Minneapolis, though Krizek and Johnson (2006) find a significant impact from on-street lanes, but not off-street trails on the disaggregate. Dill and Voros (2008) did not find sufficient evidence of objective measures of either on-street or off-street facilities in Portland, though perceptions of the availability of the infrastructure was significant. Moudon et al. (2005) also show a strong correlation for trails, but not for on-street facilities.

Research on the effects of bicycle boulevards—low traffic streets with provisions to give bicycles priority over motorists—is limited. Dill et al. (2014a) analyze the effects of bicycle boulevards in neighborhoods throughout Portland, OR with the intention of measuring change in active transportation levels, but are inconclusive in their analysis. More research is necessary for this infrastructure type.

Objective measures of infrastructure supply include facility density and distance to facility (Stinson et al. 2014; Dill and Voros 2008). Ma and Dill (2015) also used subjective measures based on how users perceive the availability of cycling infrastructure. Schoner and Levinson (2014) evaluate the connectivity of the infrastructure. They find that network discontinuities can discourage cycling by potentially forcing cyclists into mixed traffic or onto lengthy detours. Dill (2004) analyzed the correlation between four measures (street network density, connected node ratio, intersection density, and link-node ratio) to measure connectivity. Cyclist comfort levels are often influenced by discontinuities in a cycling network, reducing the overall utility of the facility (Krizek and Roland 2005). Moudon et al. (2005) found no correlation between measures of connectivity and cycling rates.

Dill and Carr (2003) find that while total availability of infrastructure is correlated with cycling rates, infrastructure alone is not likely to increase cycling. Parkin et al. (2008) point out that reasonable increases in bicycle facilities alone generate only a modest increase in cycling rates, and that forecasts from different studies will vary based on approach type and other unmeasured differences in environments and culture. Ma and Dill (2015) also report that inconsistencies may be the result of the different interaction between objective and perceptive infrastructure measures, especially visibility (Ma and Dill 2015; Sahlqvist et al. 2015). Dill (2009) states that a "network of different types of infrastructure appears necessary to attract new people to bicycling. Simply adding bike lanes to all new major roads is unlikely to achieve high rates of bicycling."

Dill and McNeil (2013) suggest that different segments of rider types have different preferences. They segment the population into four different cyclist types based on confidence level: strong and fearless, enthused and confident, interested but concerned, and no way, no how. They identify the “interested but concerned” group as the design individual, which consists of those who are curious about cycling, but are not comfortable in mixed traffic and will typically only cycle if adequate facilities are provided for their trip purposes. Handy et al. (2010) use a nested logit model to segregate potential users into four groups. These groups are defined by individuals who do not have a bike, have bike(s) but do not bike regularly, have bike(s) and are a regular transportation-oriented bicyclist, and have bike(s) and are a regular non-transportation-oriented bicyclist.

2.3.1 Route Choice

Further evidence on the relative effectiveness of different kinds of facilities (e.g. bike lanes vs. paths vs. cycle tracks) comes from studies of route choice. However, most of these studies generally measure the preferences of existing cyclists rather than the ability of such facilities to entice new cyclists (e.g. Broach et al. 2012). Studies of route preferences among potential cyclists are limited to stated-preference studies. The drawback is that results from stated-preference surveys do not necessarily predict behavior (Klobucar and Fricker 2007).

Results from stated preference studies indicate that potential users would be more likely to cycle with separated infrastructure (Parkin et al. 2008; dell'Olio et al. 2014). A stated-preference study in Canada found that users view cycling in mixed traffic as more onerous than in bike lanes or on bike paths, though less so for those with higher confidence levels (Hunt and Abraham 2007). Sanders (2014) used a stated-preference study to analyze the preferences of non-cyclists as well as current cyclists. Barrier-separated facilities were consistently identified by both groups as a comfortable alternative; striped bike lanes were generally viewed as beneficial because they provided predictability and legitimacy to cyclists, though they did not consistently increase perceived comfort. In a study investigating the factors associated with cyclists' choice between available facilities, Kang and Fricker (2013) found that off-street paths were more attractive than bike lanes, though Krizek and Johnson (2006) found that cyclists prefer on street bicycle lanes to off street trails. Streets with bike lanes were also found to be preferable as compared to streets without a bike lane or with on-street parking.

Although the type of infrastructure is an important factor, not all facilities of the same type are equally attractive to users; physical factors like urban form, slope, and connectivity to bikeable destinations influences usage, and should be considered when planning for new routes (Klobucar and Fricker 2007). A study using objective GPS data for cyclists in Graz, Austria found that actual cyclist routes differed from shortest routes by infrastructure availability, presence of flat and green areas, and absence of major roads and crossings (Krenn et al. 2014). Krizek et al. (2007) use data from an intercept study along an off-street path to find that proximity to a trail plays a significant role in propensity to use that facility, though the impact of distance varies according to trip purpose. Tilahun et al. (2006) found that cyclists are willing to travel up to twenty minutes longer to switch to off-street infrastructure. Stinson and Bhat (2005) find that experienced commuters are much more sensitive to travel time, and less-experienced cyclists are more sensitive to factors related to separation from automobiles.

In a study of 162 cyclists in Portland, Oregon, Dill et al. (2008) also used GPS data to compare chosen route against the shortest path. The studies included both utilitarian and recreational trips and participants were chosen through stratified sampling from respondents of an online survey. The demographic and personal characteristics used for stratification were cycling frequency, home location, age, and gender. The most important factor in choosing a route was stated to be minimum time followed by low traffic volume and presence of a bike lane. No significant relationship was found between route choice and slope. A comparison between shortest route and the actual route showed that people spent more time on bicycle facilities and low traffic streets than predicted by the shortest route and that the deviation from shortest route increased with length of trip.

Broach et al. (2010) extended the study by Dill et al. (2008) to develop a multivariate discrete choice model of bike route choice of cyclists in Portland to predict marginal utilities of different attributes—a model being incorporated into the Portland regional travel demand model. The path attributes used for the model were distance, slope, turns, traffic volume, signals and bike facility type. With all other parameters held constant, the log of distance was the most important factor in route choice, implying that for a short commute, a cyclist will be less willing to take the same detour as he/she would be if the commute was longer. Slopes and turns were negatively viewed, along with high vehicular traffic volumes. Traffic signals had a positive utility when the cross traffic was high, but had a disutility for low traffic streets. Bike boulevards and paths were strongly preferred while the utility associated with bike lanes was just enough to offset the disutility of traffic volume in that link. Therefore, bike lanes are preferred in streets with high traffic, but they do not add any separate value to the cyclists by themselves. Although this study has a solid methodology, the results may not be applicable to places that lack the same bike infrastructure as Portland. It also fails to differentiate between different types of cyclists in the analysis, which has been shown to have an impact on route choice (Pucher and Buehler 2008).

2.4 Individual Factors

As mentioned previously, many studies on cycling behavior have been quantitative, but qualitative studies can provide important additions to current understanding. Qualitative studies have investigated attitudes toward cycling, influence of social groups, role of families and friends, and the contribution of childhood cycling experiences (Bonham and Wilson 2012; Lanzendorf 2003; Chatterjee et al. 2013; Aldred 2013; Bonham and Koth 2010; Daley and Rissel 2011; Steinbach et al. 2011; Underwood et al. 2014; Emond and Handy 2012). Such studies help to identify important factors not typically included in surveys and can aid in survey design and interpretation of results. They can also provide important insights into the thought processes underlying the travel choices that individuals make. This section includes a summary of measures relating to propensity to cycle on an individual level.

Studies have consistently shown that males are more likely to cycle (Krizek and Johnson 2006; Akar and Clifton 2010; Stinson et al. 2015; Parker et al. 2008; Handy and Xing 2011; Xing et al. 2010; Handy et al. 2010; Dill and Gliebe 2008; Cervero and Duncan 2003). Emond et al. (2009) used data collected in medium-sized cities throughout the western United States to analyze the gender differences in cycling behavior in the United States—differences that aren't as pronounced in other parts of the world. They report that for women, age is significant, along with comfort and an expressed need for a car, but not formen. Cycling as a youth and residential self-selection were more significant for men.

Age is also an important factor in an individual’s decision to cycle (Krizek and Johnson 2006; Hankey et al. 2012; Stinson et al. 2014; Parker et al. 2008; Xing et al. 2010;

Handy et al. 2010). Hankey et al. (2012) found that the percentage of residents in a community below the age of 5 and above the age of 65 has a negative correlation with cycling. Stinson et al. (2014) found that individuals have a lower propensity to cycle for recreation the older they get after age 44. The frequency of recreational trips is at a minimum for individuals in their 40s, with those that are younger and older tending to take more trips. Handy et al. (2010) found that age is negatively correlated with bicycle ownership and use, while Xing et al. (2010) found a positive correlation with weekly miles of recreational biking.

Education level is positively correlated with cycling on the disaggregate as well as the aggregate level (Hankey et al. 2012; Krizek and Johnson 2006; Stinson et al. 2015; Emond et al. 2009). Employment status (Krizek and Johnson 2006) and hours spent at work have also been presented as significant factors (Moudon et al. 2005). The effects of income are still under debate. Krizek and Johnson (2006) found an inverse relationship. Stinson et al. (2015) also found an inverse, though weak, relationship. Handy and Xing (2011) found that age, income, and education level were not significant on their own, though homeownership is, which could serve as a proxy for the combined effects of all three. Emond et al. (2009) also found a negative correlation between home ownership and cycling. College students are also more likely to cycle (Akar and Clifton 2010; Nelson and Allen 1997).

Vehicle ownership has been shown to be negatively correlated with cycling commuting (Buehler and Pucher 2012; Dill and Carr 2003; Cervero and Duncan 2003). Conversely, Moudon et al. (2005) found that in the Seattle area individuals in households with more than one vehicle were more likely to cycle, though those trips were mostly recreation trips and vehicle ownership was likely a proxy for income. The nature of the interaction between vehicle ownership, income, and cycling is unclear. Handy and Xing (2011) also identify other important attitudes related to mode preference, such as biking comfort, liking biking, needing a car, limiting driving, liking transit, the need to run errands on the commute, the need to drive, and a preference of living in a bikable community.

Parkin et al. (2008) point out that ethnic origin is likely a contributor based on its representation of different cultures that may influence cycling behavior. Hankey et al. (2012) found that whites are less likely to cycle. However, Parker et al. (2013) found ethnicity insignificant as a predictor of changing behavior based on infrastructure investments.

Stinson et al. (2015) and Krizek and Johnson (2006) found that the number of children in the household were associated with more cycling, particularly for recreation. Other individual factors include exercise habits (Moudon et al. 2005) and good health (Emond et al. 2009).

Bike ownership has been shown to be a significant enabling factor (Moudon et al. 2005; Akar and Clifton 2010; Krizek and Johnson 2006; Cervero and Duncan 2003). Handy et al. (2010) further analyzes the predictors of bicycle ownership, suggesting the improving people's perceptions and attitudes towards biking will increase bicycle ownership and use.

In a study by Fernandez et al. (2014) regarding attitudes towards cycling, four latent variables are identified: pro-bike, physical determinants, convenience, and exogenous restrictions. Convenience, measured by efficiency and flexibility, along with exogenous restrictions, measured by danger and available facilities, are the most important elements regarding attitudes for cycling. Emond et al. (2009) also find that liking cycling increased propensity to cycle, while liking transit and the perception that cyclists are poor are negatively associated with cycling.

2.5 Trip Purpose

The needs, behaviors, and preferences of cyclists may vary based on trip type. It is likely that trip purpose plays at least a small part in explaining inconsistencies between studies in this regard. Many studies only consider commute trips due to the ease of obtaining aggregate commuting data, which may miss valuable data from other trip purposes (e.g. Krizek et al. 2009a; Cleaveland and Douma 2008; Buehler and Pucher 2012; Dill and Carr 2003; Nelson and Allen 1997; Jones 2012; Parkin et al. 2008). Others build disaggregate bicycle commute mode choice models (dell'Olio et al 2014; Handy and Xing 2011). Some studies account for all trip types with no specification of purpose (Hankey et al. 2012; Parker et al 2013; Heinen et al 2015). Other studies account for differences in behavior between commuting/utilitarian trips and recreational trips and models include separate considerations for each (Stinson et al 2014; Dill and Voros 2008; Xing et al. 2010). Buehler and Pucher (2008) suggest that separate facilities along utilitarian routes will see more use than recreational routes.

Heinen et al. (2013) investigated the correlation of work-related factors in the Netherlands and the decision to cycle to work and the frequency of bicycle commuting. Positive attitude towards cycling, colleagues' expectations of cycling to work, bike storage, changing facility, and needing a bicycle during office hours were positively associated with the decision to cycle to work, while facilities for other modes, commute distance, and the need to transport goods were negatively correlated. Frequency of commuting was negatively affected by distance and the provision of either a transit pass or free automobile parking.

Buehler (2012) likewise examined the role of bicycle parking, cyclist showers, free car parking and transit benefits in the Washington, D.C. Metro Area. Presence of bike parking, showers, and lockers was significantly associated with higher propensity to cycle, while free car parking and high vehicle ownership reduced it. Car parking and other facilities at work are also addressed by Heinen et al. (2015) and Heinen et al. (2013).

Kroesen and Handy (2014) use data from a Dutch mobility panel to analyze factors relating to behavior of four groups: non-cyclists, non-work cyclists, all-around cyclists, and commuter cyclists. All-around cyclists are the most stable in their behaviors, so efforts to increase users in that type will lead to the most stable patterns. Factors that encourage more cycling to work may also have a positive effect on non-work trips (Kroesen and Handy 2014). However, the experience in the Netherlands may not be consistent to that of the United States.

2.6 Environmental Factors

Many of the best studies to date have been conducted in locations with very different land use and transportation policies. Studies in communities where cycling is rapidly increasing and community acceptance is moderate have been limited, though example studies include Los Angeles (Stinson et al. 2014) and New Orleans (Parker et al. 2015).

For results from one specific location to be generalizable, the environmental factors must be considered.

Weather has been found to be significant on an aggregate level in multiple studies. Dell'Olio et al. (2014) account for the presence of bad weather for an individual's trip, while other studies include more objective data to assess weather conditions. Variables measuring weather that have been significant include number of days above 90 degrees F (Buehler and Pucher 2012), annual precipitation (Buehler and Pucher 2012; Parkin et al. 2008), days of precipitation (Dill and Carr 2003, Nelson and Allen 1997), mean high temperature (Nelson and Allen 1997), and mean temperature (Parkin et al. 2008).

Urban form appears to be significant in multiple studies. A study in the Netherlands found a significant influence of urban form on trip length and cycling rates (Susilo and Maat 2007). Other variables that have been shown as significant in the United States on the aggregate level include sprawl index (Buehler and Pucher 2012), tract characteristics (Stinson et al. 2014), and population density (Parkin et al. 2008; Pucher and Buehler 2006). On the disaggregate, proximity to freeways and distance from downtown are both deterrents (Dill and Voros 2008), while subjective/perceptive variables (Moudon et al. 2005), settlement size (Heinen 2015), and transit availability (Handy and Xing 2011; Xing et al. 2010; Handy et al. 2010) are also influential. Conversely, Cervero and Duncan (2003) found impacts of the built environment to be marginal, though darkness was a major deterrent.

Cole-Hunter et al. (2015) performed a study identifying environmental factors in Barcelona pertaining separately to home, work, and route. They found that vegetation along the route is associated with more cycling, while changes in elevation are associated with less cycling (Cole-Hunter et al. 2015). Holle et al. (2014) conducted a stated-preference survey and found that vegetation can make cycling infrastructure more inviting to cyclists and non-cyclists. Slope and elevation differences have also been identified as deterrents to cycling (Nelson and Allen 1997; Parkin et al. 2008; Dill and Voros 2008; Cole-Hunter et al. 2015).

Dill et al. (2014b) suggest that the built environment impacts cycling behavior through its effects on attitudes and perceived behavioral control. Bicycle infrastructure can likely have an effect in that way, though other aspects of the built environment have a different effect; adding bike lanes to an otherwise poor cycling environment may not provide an increase in usage.

2.7 Policy and Cultural Factors

Policy and activist groups have had significant influence in the past for both encouraging cycling and lobbying for more facilities in Davis, CA (Buehler and Handy 2008). Residents lobbied heavily for facilities in Davis beginning in the 1960s. Facilities came as a result of advocacy groups and policies and the cycling culture developed. However, cycling rates have been decreasing since 1990, accompanying changing demographics, intercity commuting, and increased transit. Programs and system expansion have ceased, likely leading to a deterioration in cycling culture (Buehler and Handy 2008).

Caulfield (2014) addressed the conglomerated effects of infrastructure investments and other programs on the aggregate in Dublin. Programs include financial incentives, promotion, bike share, and political support. The combination of these produced an increase in commute mode share from 2006-2011, though it is recommended that targeted policies be adopted to reach those on the verge of switching to cycling. Programs and other policies that often accompany infrastructure investments are also expected to increase cycling (Caulfield 2014), so it is difficult to quantify and disentangle the effects of "hard" and "soft" interventions. In Boulder, CO after nearly $100 million worth of investments in bike, pedestrian, and transit infrastructure between 1990 and 2009, it was estimated that each $10 million invested corresponded to a 1% increase for alternative modes (Henao et al. 2015). The Nonmotorized Transportation Pilot Program (NTPP) was developed by the Federal Highway Association (FHWA) in an effort to assess the cost-effectiveness of different strategies in increasing nonmotorized mode shares. Each of the four pilot communities (Columbia, MO; Minneapolis, MN; Sheboygan County, WI; Marin County, CA) saw a significant increase in nonmotorized travel over the course of the pilot from 2007 and 2010. It is not readily apparent whether the funding was provided in response to demand, or if the demand followed the funding (FHWA 2012).

Pucher and Buehler (2008) suggest that the difference between cycling levels in the United States and European countries is primarily due to policy differences, though infrastructure and other factors likely play a role. Ogilvie et al. (2007) also find that targeted behavior change programs were the most effective. Pucher and Buehler (2006) studied the differences between Canada and the United States to explain factors that influence the higher cycling rates in Canada. They find that the high cost of vehicle ownership along with pro-cycling policies and programs in Canada are significant factors promoting cycling.

In a study comparing cycling throughout Europe, Rietveld and Daniel (2004) identify a cultural tradition that may play a significant role in the individual decision to cycle that could even be stronger than other characteristics. Chataway et al. (2014) compared cyclist behaviors and attitudes between Brisbane, Australia (an emerging cycling city) and Copenhagen, Denmark (an established cycling city). They found that users in the less-established cycling city were more uncomfortable in mixed traffic and felt more fear of traffic, making them more likely to avoid cycling.

Correlation has been established between cycling rates and safety (Pucher and Buehler 2006; Buehler and Pucher 2012) so measures that improve the safety of the cycling environment can jointly serve both interests by also encouraging cycling. A more comprehensive analysis of bicycle safety was performed by DiGioia et al (2017).

2.8 Summary

Although there has been much work to study the needs and preferences of cyclists, there is an alarming shortage of research involving current and potential cyclists from places in the U.S. that are more representative of the typical cycling scene. The few studies that do explore stated preferences from the general population do not link these preferences back to characteristics about the type of cyclists. The research conducted in this thesis seeks to confirm findings from studies conducted in cycling hubs, along with explaining the differences in preferences among different types of cyclists.

CHAPTER 3. FOCUS GROUPS

3.1 Methodology

This chapter focuses on the findings obtained through focus groups held in April 2016 in Chattanooga, TN, Opelika, AL, and Anniston, AL. The focus group results had the dual purpose of providing qualitative examples of problems faced by cyclists in this part of the country and refining the survey instrument that was late deployed in the study areas.

3.1.1 Focus Group Recruitment

Six focus groups were organized with two sessions in each of the three locations. Recruitment efforts were intended to attract both regular cyclists and those who do not currently bike and included emails to community groups and advertising on Facebook. The only requirement for participation was to be physically capable of riding a bike. Participants were offered a modest incentive of $40 to attend a 90-minute focus group held at a venue located near planned bicycle facility improvements. Table 3 shows the demographic breakdown of participants.

Table 3 Summary of Demographic Information of Focus Group Participants

	Gender		Ethnicity		Rider Frequency			Age				Kids at Home		**Total**
	Male	Female	White	Minority	Never	Occasional	Frequent	18-24	25-44	45-64	65+	Yes	No	
Opelika 1	6	4	9	1	1	6	3	0	3	6	1	5	5	**10**
Opelika 2	6	2	8	0	1	5	2	1	4	3	0	3	5	**8**
Anniston 1	5	5	10	0	0	3	7	1	8	1	0	7	3	**10**
Anniston 2	1	1	2	0	0	0	2	0	1	1	0	1	1	**2**
Chattanooga 1	7	6	7	6	2	2	9	0	9	3	1	3	10	**14**
Chattanooga 2	5	4	8	1	1	4	4	2	4	3	0	1	8	**9**
Total	**30**	**22**	**45**	**7**	**5**	**20**	**27**	**4**	**29**	**17**	**2**	**20**	**32**	**52**

3.1.2 Focus Group Content

As the focus groups began, participants were prompted to share background involving their experience as a cyclist and how they view the bikeability of their community. Respondents were also asked to share their thoughts on things that make them feel comfortable when biking.

For the second stage, images of various infrastructure types were created in Adobe Photoshop and presented to respondents. One common roadway setting was chosen as a base image to control for urban environment, weather, and other contextual variables. The images were designed such that the background scenery would be recognizable by urban dwellers as an in-town neighborhood and rural dwellers as a small town.

Variations were made based on different types of bicycle infrastructure, the presence or absence of on-street parking, and the number of vehicular lanes. Each scenario exhibited a moderate amount of vehicular traffic that would allow for near-free flow conditions with a reasonable amount of opportunity for vehicle-to-cyclist interactions. Nineteen total images were prepared. The images for on-street infrastructure are presented in Figure 2. The infrastructure includes sharrows, bike lanes, and traffic-side buffered bike lanes. Parking-side buffered bike lanes were also included for scenarios with a parking lane. Each infrastructure treatment was shown for four roadway sections: two-lane, two-lane with parking, four-lane, and four-lane with parking. All four images with a sharrow marking were presented and discussed first, followed by all bike lane images, then buffered bike lane images. After this set of images, separated infrastructure images including protected bike lanes and a shared use path were shown, which are displayed in Figure 3. In the interest of time, not all lane and parking configurations were shown for the protected facilities. Protected bike lanes scenarios were built using the same urban environment as before, but the nature of a shared use path required a separate built environment.

Figure 2 Combinations of on-street bicycle infrastructure used in focus groups

Figure 3 Combinations of physically separated bicycle infrastructure used in focus groups (shared use path image courtesy of Atlanta Beltline Inc.).

Respondents were invited to indicate their comfort level in riding in each of the presented environments as Very Comfortable, Somewhat Comfortable, Somewhat Uncomfortable, or Very Uncomfortable. Participants were invited to explain their reasoning and express their concerns about each scenario.

Although the focus groups were intended to address segment facility types, it was anticipated that many respondents would want to express concerns about intersections as well. An additional set of images were presented about bike boxes, two-stage turn queues, and protected intersections, although this section was more informative. Respondents generally liked the more protected intersections, but had not experienced enough alternatives to share real opinions about the infrastructure. Additional images were presented on green bike lanes and neighborhood greenways (residential streets, sometimes called bike boulevards, utilizing traffic calming measures to give preference to bikes). Participants liked the more designated facilities that showed where bikes belonged, but neighborhood greenways were not given enough time to solicit a response.

3.2 Infrastructure Findings and discussion

When presented with different configurations of roadway characteristics and infrastructure types, participants were asked to state their comfort level (from very comfortable to very uncomfortable). In general, participants felt they would be more comfortable biking on infrastructure types that were more separated from both parked and moving cars. Barrier or buffer separated bike lanes with no curb parking were viewed as most comfortable, followed by bike lanes with no on-street parking. The presence of curbside parked cars and associated dangers from opening doors, and from cars parking and leaving the curb were the most consistent concerns noted. Hazards from turning cars at intersections and hazards from moving cars were less acute concerns, although participants noted an increase in comfort when a buffer or barrier was introduced between moving cars and bicycles.

3.2.1 Differences in Comfort for Various Levels of Infrastructure

Many participants felt cautious about sharing a lane with the sharrow marking with vehicular traffic. Many were unfamiliar with the sharrow marking, and others felt that the marking was essentially useless. It was viewed as a cultural disaster in a city where not a lot of people bike. The marking gives priority to cyclists over motorists but does not address the issue of how to adapt drivers' behavior to share space with cyclists, especially when people think that bicycles are interfering with through traffic. Several participants also felt uncomfortable with the idea of having cars waiting behind them, with one stating "there is no room to get out of the way," and another preferring a place to get out of the way every few hundred feet. This lack of comfort led some to prefer an additional lane with the sharrow in the right-most lane, in effect creating a "slow lane" for cyclists and a passing lane for motorists.

The existence of any sort of spatial separation was influential in increasing perceived comfort. Some cyclists had experienced harassment by motorists, so avoiding conflict between cyclists and faster motorists was viewed as an important advantage of bicycle lanes. A bike lane alone was enough to make 75.5% of participants (compared to 17.0% with the sharrow) feel very comfortable in the case of the 2-lane no parking roadway. As noted above, bicycle lanes without adjacent curb parking were preferred to avoid dooring hazards. There was some concern about trash and debris in bicycle lanes located near the curb, with one participant stating, "you are guaranteed a flat tire." Some participants also felt uncomfortable about drivers who may see the bike lane as an excuse to drive faster and cut it closer, and advocated for signage and education for drivers.

Participants liked the separation from traffic provided by the buffered bike lane, with one participant stating that it "builds in the 3-foot passing rule." They also like the visual barrier of the white diagonal paint in the buffer zone, though some would still like ways to increase visibility by perhaps using a brighter yellow or red pavement (such as in the Netherlands). Parents perceived this as being better for riding with kids, though they would also like cyclist education for children. Some were concerned that the added width of the buffer would make the bike lane just wide enough to be used for deliveries or other forms of impromptu parking.

With only 49.1% responding as very comfortable, the shared use path image was viewed less positively than all protected bike lane scenarios as well as all bike lane and buffered bike lane scenarios that didn't include parking. Only 1.9% felt very uncomfortable, but some were not pleased with the lack of lanes and bike symbols and the potential for pedestrians to block the path. Most felt that this type of infrastructure was more suitable for recreational riding, with one participant describing the experience of mixing pedestrians and cyclists as "not dangerous, just annoying." One noted "there are too many variables, you got slow bikers, you got fast bikers, walkers that have no clue of what is going on, and you got walkers with dogs on a retractable leash." Another mentioned that "if the public were educated, I would be OK", but right now everybody feels this is their own space. Overall it was viewed as good for kids, with one parent stating, "if I was riding for 20 miles, I would not choose this, but if I am going with my kids for an ice-cream, this is great!"

3.2.2 Impact of Curbside Parking on Cyclist Comfort

The presence of curbside parking was one of the biggest deterrents to participants. In the two-lane parking scenario, the presence of parking nearly neutralized the positive effects of bike lanes and buffered bike lanes. Some of the primary concerns about biking in the presence of on-street parking were the threat of opening doors and cars pulling into and out of parking spots.

Participants were less comfortable about sharrow situations when parking was introduced, citing the same reasons as above. A minority of participants noted that the presence of parking likely would slow traffic, but this did not manifest itself strongly in the overall comfort level expression. These comments were typically limited to configurations with the sharrow marking, in which case the cyclist is expected to take the lane, increasing visibility and distance from doors.

In bike lane scenarios, participants recognized that the bike lane was near the parking zone, which increased the threat of the door zone along with the hazard of the parking maneuver itself. This made them more sensitive to hazards on both sides, increasing the perceived hazard. Some felt better with the existence of the bike lane, but not if the bike lane was located within the "door zone". One participant explained that "it's achieving the sense of safety, so I am inclined to go faster, and that would make me exposed to get doored." Overall, when cycling next to parking, participants were split between whether a sharrow or bike lane would be preferable. Many felt that a bike lane between a travel lane and parking lane "sandwiched" the cyclist between hazards. Another noted that a door zone bicycle lane made her feel "smooshed with nowhere to go". This varied from the effect of a sharrow infrastructure type in that a sharrow allows cyclists to take the lane and get away from the parking.

The sense of comfort provided by the buffered bike lane was also reduced by the addition of parking. The buffer, which was shown both separating the bike lane from the car doors or separating them from the moving traffic, made participants feel a little more comfortable as opposed to just a bike lane. One participant said, "I like it a little better than a regular bike lane, because if somebody opens the door, there is somewhere to go." There were still lingering concerns about the actions of drivers in the parking zone. Flipping the buffer to the parking side helped ease a little bit of discomfort, as many participants felt more concerned about cars from the parking side to do something unexpected than from the travel lane. However, some noted that the extra space still doesn't get the cyclist out of the blind spot of a driver trying to pull into traffic. Some noted this could be fine for experienced cyclists, but not others.

3.2.3 Role of a Physical Barrier versus Buffered Lanes

Interactions with parking cars was viewed as a primary concern throughout the focus groups. None of the previously discussed infrastructure types were satisfactory at alleviating the concerns of participants. Some asked if there was a way to get cyclists entirely out of the way of cars trying to park (or vice versa).

Compared to the best-case scenario without a physical barrier (buffered bike lane), the addition of the physical barrier was influential in overcoming the negative implications of the least preferable roadway configuration of four-lane with parking. The primary concern with the introduction of protected bicycle lanes to the right of parking was the challenge of pedestrians crossing through the lanes to parking, with one participant stating that the setup "kills visibility for everybody." Planters were a slightly preferred barrier for most participants due to an added sense of security from vehicles and pedestrians, while others preferred bollards due to increased visibility and reduced risk of injury from crashing into the barrier. In either case, one participant said he would like to see reflectors on the barriers to improve nighttime visibility. The participants traveling with children were more in favor of the protected bicycle lanes despite the potential for pedestrian conflicts in the cycle track due to the slower and less predictable nature of travel with kids.

Two-way protected bicycle lanes (cycletracks) were not viewed as substantially different from one-way protected bicycle lanes (cycletracks). There was also concern about intersection treatments, and the potential to encourage wrong way riding. Concerns for this infrastructure were mostly those of consistency and education. The higher visibility of two-way cycletracks may help non-cyclists to notice that there is a bike lane.

3.2.4 Concerns at Introducing Protected Bicycle Lanes and New Intersection Treatments

Some of the more experienced cyclists expressed concern about the protected bike lanes in which parked cars and bollards separated cyclists from moving traffic. They noted the value of having "an escape route" from opening car doors or pedestrians stepping into the cycle track which was reduced in narrow cycle track configurations. The reduced visibility of cyclists using protected bike lanes was a concern. These cyclists preferred buffered bicycle lanes, green lanes, and bicycle lanes without parked cars as solutions which provided separation from vehicle traffic while preserving "escape routes" to merge into traffic to avoid debris, merging cars and other hazards.

In Chattanooga, where a cycle track separated by a curb and parking lane has been introduced, there have been some challenges with motorists opening car doors into the lane and tripping over the curb, and with cyclists trying to merge from the protected bike lane at intersections. Two stage turn queue boxes in Chattanooga are used to facilitate left turns from the protected bike lanes, but when asked about them, few of the focus group participants knew how they should use them. By contrast, when focus group members were shown a “protected intersection” or “Dutch intersection” where bicycles are protected by a second curb as they wait to turn left in two stages, the proper location for all modes to wait was intuitively obvious. Unfortunately, participants felt that securing funding for such a design was “extremely unlikely.”

3.2.5 Impact of Number of Automobile Lanes

The addition of extra automobile travel lanes had a tendency to decrease comfort in most cases. Several participants noted throughout that although they felt that this change from the base condition decreased comfort, it was still more comfortable than the parking change.

In the sharrow without parking case, 25.5% of participants responded as “very comfortable” after the addition of the extra travel lane, which was surprisingly more than the 17.0% without the extra travel lane. Some stated that this change made them more comfortable because vehicles have a lane to pass the cyclist. This helped solve the problems posed for those who didn’t want to get in the way. When parking was also introduced, the extra lane reduced those expressing very/somewhat comfortable from 54% to 42%, as it seemed to increase the amount of activity beyond the threshold that participants could comfortably process. Therefore, in sharrow situations, if parking was present, participants preferred a two-lane roadway; without parking, the extra lane of a four-lane road was preferred.

For scenarios involving bike lanes and buffered bike lanes there was a modest decrease in the number of respondents who responded as “very comfortable” when parking was added. However, in both cases when parking wasn’t involved, respondents were still mostly in the “very comfortable” or “somewhat comfortable” range. When both parking and extra travel lanes were combined, respondents did not feel comfortable with either a bike lane or a buffered bike lane. It seemed that either additional hazard on its own increased stress in a manageable way, but the combination of the two seemed to push most respondents over the edge to the uncomfortable side. One participant even exclaimed “please don’t build that!” when presented one of those cases.

3.2.6 Other Infrastructure Factors

Most respondents liked the idea of having bicycle space marked with green paint to better designate cyclist space in the right-of-way. There were some that were concerned that the paint would become slippery in the rain, but the color difference was still viewed as a positive.

Respondents seemed to like the idea of neighborhood greenways / bike boulevards. However, there was a general attitude that the traffic calming purposes would be used to get vehicles out of residential neighborhoods, rather than to make the streets necessarily more bikable.

Reactions varied regarding the use of intersection treatments. Most participants felt like the purpose of the bike box is unclear, and drivers would not observe them without proper education. A two-stage turn box was viewed more favorably by some, as many of the concerns raised throughout the focus groups was the difficulty of making left turns. Many participants still felt like they would rather do a vehicular left turn to clear the intersection faster, though this was a stronger theme in the more rural locations of Opelika and Anniston. Protected intersections were viewed as very comfortable among most participants. Many said that it was self-explanatory and easy to navigate for cyclists and drivers, though participants in more rural Opelika and Anniston recognized the financial barrier in implementing these in the places they cycle.

Respondents also voiced opinions about the importance of the general cycling network. Many felt like they knew of comfortable infrastructure in their neighborhoods, but the system as a whole was lacking. One participant noted “a network that allows me to get where I want to go… it’s not there.” Another respondent who started biking while living in China said, “We don’t have the infrastructure and the biking culture here–I don’t ride my bike as much as I would like.”

3.3 Cycling Comfort Findings and Discussion

Throughout the course of the focus groups, the primary factor that influenced participants’ perceived comfort was how safe they felt on the route. Although this is a typical concern, it became apparent that the responses from these focus groups differed from findings of similar studies conducted in other regions. In several of the focus groups conducted through this study, participants shared horror stories of someone they knew who was seriously injured or killed while cycling, and it seemed that the concerns that were voiced were based on this type of fear. Surprisingly, weather and hills did not come up in any of the focus groups, however, none of the focus group locations are particularly hilly, and the weather in the south is generally nice, with the exception of the midday heat during the summer. This section contains a discussion of the common attitudes about the sources of discomfort, particularly driver behavior, the number of cyclists, and children and cycling.

3.3.1 Concerns about Drivers

A primary concern for cyclists in these communities was driver expectations, and that users—particularly drivers—wouldn't know how to navigate the infrastructure. One participant, who previously lived in Portland, Oregon, stated: "I am very comfortable with riding, but I am very afraid of drivers here."

Participants felt like there was little keeping drivers in check. Due to the lack of enforcement of laws, they looked to infrastructure design to perform the role of maintaining the integrity of cycling laws. Participants in nearly every focus group offered examples of drivers misusing infrastructure such as parking in a buffered bike lane or using a bike lane as a loading zone. There was a real fear that blocked bike lanes would require newer cyclists to enter the general stream of vehicle traffic when they were unprepared to do so. This was cited as a reason for preference of protected bike lanes, as it becomes much harder to misuse.

Other concerns stem from drivers' apparent inattentiveness and ignorance of laws, with one participant stating, "every single driver that comes up is less than two feet away," and another saying he feels the need to educate drivers all the time. Many participants favored buffered bike lanes for this reason. One participant explained that he liked that the infrastructure "built in" the three-foot rule. This is in contrast to the common complaint about bike lanes: that there is nothing to stop drivers from violating this rule.

Participants also felt that drivers in the South are generally more aggressive, making cyclists feel more uncomfortable, particularly in more rural settings. One participant from Chattanooga stated, "outside of downtown, things get very sketchy very fast, with some very aggressive drivers." This aggression, coupled with high travel speeds, made participants very eager to have more separation than what may be found elsewhere.

3.3.2 Strength in Numbers

Some participants expressed that an increase in the number of cyclists could help educate drivers. Many participants felt they would like to wait for more people to bike before joining in, with one participant stating, "I would feel better if there was more density of people doing this." Reasons for this are that many felt that drivers are not conditioned to expect cyclists. Some felt that the presence of bicycle infrastructure builds in an expectation, but most expressed that they would feel much more comfortable cycling on a route where cyclists are common.

Another concern was that many felt the cyclists were in the minority in the South. Some participants recounted harassment encounters from their own cycling experience or from that of a friend. This was particularly an issue for women in Chattanooga, with one stating "I don't want to go by myself."

3.3.3 Children and Cycling

There were several participants throughout the focus groups who had young children at home. The format of the study excluded the participation of minors, so those with children were asked to voice their opinions for themselves as well as on behalf of their children. Across the board, perceived safety was the governing factor of whether the parents would feel comfortable with their kids cycling, with parents being much more conservative in their expression of comfort on behalf of their children than for themselves.

Many participants noted the need for bicycling education for children as well as adults, with some of the current cyclists being involved as League Cycling Instructors, youth cycling instructors, or in other capacities.

Most felt that, apart from parking lots, parks, and slow residential streets, there were not ample places in their communities for children to bike. One participant stated "There is nowhere that is safe near where I live—I feel so stressed when I see the kids in the street." Another stated that they avoid all roads that have any traffic and that don't look safe.

3.4 Summary

The findings from the focus groups provide qualitative information about the concerns current and potential cyclists have about cycling in the southeastern United States. Previous studies have focused primarily on cyclists in regions where cycling is already highly visible. These focus groups revealed that perceived safety from moving vehicle collisions and adjacent parked cars was a major factor in potential cyclists' willingness to use infrastructure, with substantial concern about unsafe driver behavior. Participants were attracted to infrastructure with a higher degree of separation from drivers, as they felt they would be safer from inattentive and aggressive drivers, both in the travel lane and the parking lane. Hazards from dooring and cars parking were among the highest concerns, followed closely by hazards from cars turning into or overtaking bicycles. Buffered bicycle lanes and protected bicycle lanes with a physical barrier such as bollards or planters were all viewed as substantially improving comfort, but even basic bike lanes were reassuring provided they were not adjacent to car parking.

When curbside car parking was introduced, perceived comfort levels plummeted, and only recovered with buffering to place the bike lane outside the door zone or physical separation from parked cars and the door zone. Eliminating curbside parking next to bike lanes, as is common in Europe, appears to increase comfort along with more complex and expensive buffering or protected bicycle lanes.

The focus groups analyzed several scenarios for buffered and protected bikeways which could provide needed reassurance to inexperienced cyclists who may want to try cycling. More experienced cyclists noted important safety and education challenges with integrating protected bike lanes and one or two-lane cycle tracks at intersections. Bicycle facilities such as the two-stage-turn queue box were seen as complex to use and explain. Participants generally preferred more intuitive bicycle infrastructure such as the protected intersection or reverting to vehicular cycling strategies.

While qualitative in nature, the results of these focus groups will ultimately prove useful in informing the design of future quantitative research efforts such as survey deployment in similar geographic regions. It is also anticipated that this information will enter discussion of cyclist needs and preferences when it comes to cycling infrastructure design.

CHAPTER 4. FIRST WAVE SURVEY DESCRIPTION

4.1 Survey Method

The initial sample of respondents invited to complete the first wave survey was built with a *stratified random sampling* methodology. For the “treatment” neighborhoods, we focused on the residents that live within a radius of 0.5 mile to 1 mile from the location of the coming new bike infrastructure. For the “control” neighborhoods, we identified similar-sized areas matched on key variables, including population and employment density, mean income, household size, race and ethnicity, and presence of student population, with similar characteristics of regional and local transportation accessibility, e.g. proximity to a freeway or other major highways, access to transit, and existing bike network. These comparisons were done using American Community Survey (ACS) data and verified using demographic data purchased with the addresses from the targeted marketing company.

The intent of the survey is (1) to identify the composition of the population of current and potential bicycle users, and their characteristics, (2) to assess the size of the persuadable market of potential bicycle users, (3) to assess preferences for “treatments”, e.g. different types of bicycle infrastructure and facilities and (4) to investigate the relationships of several dimensions of interest, including users' personal attitudes and preferences, current lifestyles, land use patterns, and sociodemographic traits, with current travel behavior and the propensity to engage in bicycle use. Questions were designed to address all of these issues.

4.2 Survey Design

The survey was designed through an extensive process of writing, debating, and rewriting over a six-month period to identify and refine survey questions. The goal was to produce a survey instrument that took approximately 30 minutes to complete. This allowed balance between obtaining a thorough set of variables and limiting the time commitment from participants. To reduce potential response biases, the content of the survey was purposefully broader than just cycling to help ensure that participants remained interested and did not quit the survey if they did not recognize themselves as the "biking type". To the extent practical, we reused questions from previous surveys, both to rely on previously tested and vetted questions and to maximize opportunities for cross-study comparisons of results. The resulting survey contains six sections, including:

A. Attitudes
B. Technology usage
C. Home
D. Daily travel
E. Bicycling experience
F. Demographics

The complete survey instrument is found in Appendix A. Particular attention was given to attitudinal questions regarding car dependence, environmental concerns, exercise, land use, mode preferences, peer influence, time pressure, and multitasking. To assess bicycle preferences, we used Adobe Photoshop to modify an image of a generic low-rise downtown streetscape into sixteen images, with all combinations of four bike infrastructure classes (sharrows, bike lanes, buffered bike lanes, and protected bike lanes), presence or absence of on-street parking, and two versus four traffic lanes. The background image was intended to be seen as a small-town downtown or lower-density section of downtown to allow it to be visualized in most towns were it to be used. An additional image of a multi-use trail was also used, but due to the nature of this type of infrastructure it was impossible to use the common streetscape. It was impractical to ask each respondent to rate all 17 images, so we prepared four different versions of the survey, using a modified factorial design that gave each respondent 6 images to evaluate. Each respondent was presented with one image from each of the four types of on-street infrastructure (sharrows, bike lanes, buffered bike lanes, and protected bike lanes) for the same roadway characteristics, and at least one additional image from among those four types which differed either in whether parking was present or not, or in whether the street was two-lane or four-lane. The sixth image was either another "double" from among the four infrastructure types or portrayed a multi-use path as shown in Figure 4. These combinations ensured that across the entire sample, specific comparisons of interest could be made. All 17 images were tested in the focus groups and some modifications were applied. Figure 5 displays the images used for the 16 on-street infrastructure configurations.

Figure 4 Image for Multi-use Paths Used in Survey

The survey was pretested with graduate students, the NCHRP panel, and members of the public. Both an online version and a paper version were prepared. All four versions of the final survey are attached to this report in Appendix A. The survey is intended to be generic enough for use across the country for future comparison of results in varying locations (beyond the scope of this project).

The survey was initially deployed in August 2016 and responses were collected throughout late summer. A letter printed on cardstock was sent to about 24,000 possible participants with instructions to either return a postcard for a hard copy of the survey or to complete it online using a code. Email addresses and a toll-free number were established to answer questions. Incentives of $2 were offered to those who responded. Unfortunately, despite the best efforts of the team, the responses were far fewer than anticipated, with only 175 online responses and 276 postcards returned. In retrospect, we believe that the double barrier of requiring either the returned postcard or the entry of the survey URL online (in turn requiring a computer and internet connection) was too high to capture many respondents.

To remedy this problem, the entire survey was printed and mailed to the full list of residents who had not yet responded to the survey in October 2016. It was our hope that by receiving an actual paper copy after the initial letters, the residents would be more likely to respond to the survey. We continued to use the 1-800 number and email address to respond to survey questions and responses were assembled and entered from November to February. Each paper survey was entered (coded) twice and the two datasets were compared to identify and correct any coding errors that were introduced in the data entry process.

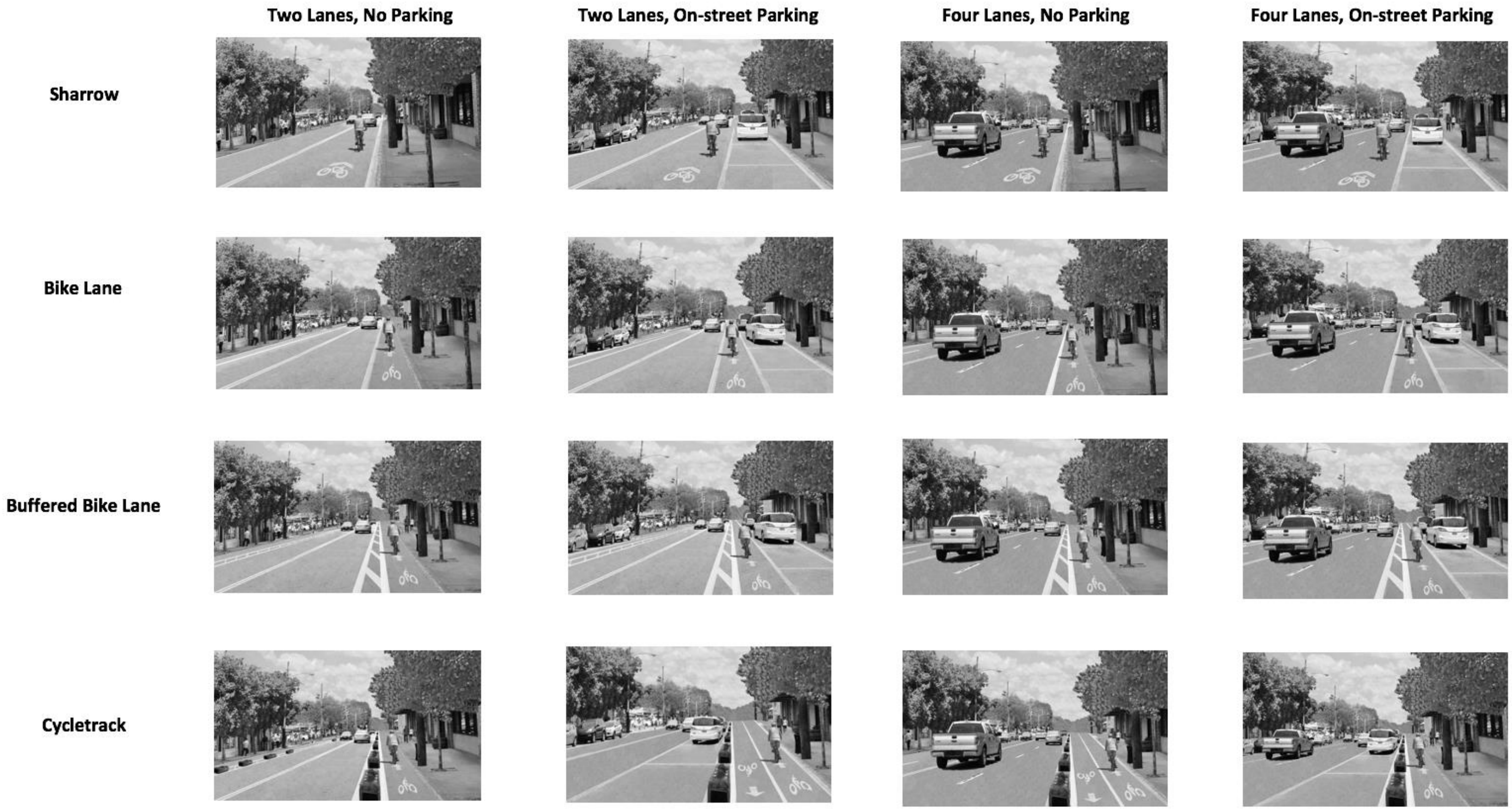


Figure 5 Images of Infrastructure Configurations for Different Roadway Layouts Used in Survey.

4.3 Survey Response

The survey received 1,223 responses in total: 178 online and 1045 on paper. Responses were distributed by area as shown in Table 4.

Table 4 Raw Survey Response Count by Area

Area	Households Contacted	Responses	Response Rate	Treatment / Control
Anniston	4347	198	4.6%	Treatment
Opelika	3362	185	5.5%	Treatment
Chattanooga	4400	239	5.4%	Treatment
Talladega	3305	93	2.8%	Control
Northport	3707	234	6.3%	Control
Birmingham	4292	274	6.4%	Control
Total	23,413	1223	5.2%	

Although all of the areas received lower than the desired 10% response rate, this sample is large enough to have useable results from the survey in all areas. The results in Talladega are enough for a control area, although segmenting by demographics or other variables will be limited.

As discussed previously, four different survey versions were used to limit the number of images that any one respondent saw. The four versions were evenly divided among the six areas. As shown in Table 5, the responses were fairly evenly distributed as well. Two respondents dropped the survey before being assigned a version and are not included in this table.

Table 5 Raw Survey Response Count by Version (N=1,221)

Version Number	Responses	Percent of Total
1	305	25.0%
2	317	26.0%
3	314	25.7%
4	285	23.3%

4.4 Data Cleaning

A general screening and more in-depth review for missing data was utilized. Unfinished surveys and those with a low proportion of questions answered were removed entirely from the raw database. An additional assessment was undertaken on a section-by-section basis, using commonly accepted methods to fill in small amounts of missing data, and excluding cases with an unacceptable amount of missing data. Cases were evaluated for inclusion or imputation on different completion criteria for each section, as follows:

- Section A (Attitudes): Cases with more than five missing items (out of 38 in the section) were deleted, otherwise missing items were imputed using expectation maximization.
- Section B (Technology usage): Uncleaned to date
- Section C (Home): Uncleaned to date
- Section D (Daily travel): Logical variables were introduced to account for any discrepancies between employment data and commute pattern data.
- Section E (Bicycle experience): For key dependent variables and segmentation variables, all missing responses were excluded from the respective models.
- Section F (Demographics): Where available, responses with small amounts of missing sociodemographic data were supplemented with information from our targeted marketing database.

After cleaning, the raw database was consolidated into a working database of 1,178 respondents. Each person responded to 6 different images, so there were up to 7,068 image responses for each of the 4 questions (comfort, safety, willingness to try, and frequency), though cases were excluded from their respective models due to item non-response.

4.5 Combined Study Area Statistics

The final section of the survey included several demographic questions to illuminate the participant's personal and household characteristics. The purposes of this section are primarily to illustrate trends in demographics and to allow comparison to the populations to which the respondents belong. Note that in most cases the most appropriate comparison is 5-year 2014 ACS data at the block group level, but in others the Targeted Marketing Data (received from Direct Mail) from which the original addresses were obtained was used for comparison to the respondents. Additionally, these statistics have been computed using the cleaned dataset of 1,178 cases.

Error! Reference source not found. shows the respondents' household incomes and a comparison to the study area population household incomes. As is typical for self-administered surveys of the general population, the respondents tend to be wealthier than the study area populations.

Table 6 Survey Respondents' and Study Area Population Household Income (N=1,146, P<0.001*)

Household Income	Responses	% of Respondents	% Respondents Answering Question	% Population from ACS
$15,000 or less	179	15%	18%	29%
$15,001 - $30,000	140	12%	14%	23%
$30,001 - $50,000	151	13%	15%	19%
$50,001 - $75,000	177	15%	18%	14%
$75,001 - $100,000	118	10%	12%	6.4%
$100,001 - $125,000	69	5.9%	7.1%	4.2%
More than $125,000	142	12%	15%	5.6%
Prefer not to answer	170	14%		

*Chi-squared goodness-of-fit P-value, where smaller values indicate greater departure of the sample from the population distribution. Remaining tables reporting a P-value follow the same convention.

Error! Reference source not found. shows the respondents' household sizes and a comparison to the study area population household sizes. The small P-value for the Chi-squared goodness-of-fit test indicates a divergence of the sample from the population. Inspection of the data indicates that fewer one-person households responded, while more two-person households responded to the survey.

Table 7 Survey Respondents' and Study Area Population Household Sizes (N=1,178, P<0.001)

Household Size	Responses	% of Respondents	% Respondents Answering Question	% Population from ACS
1 person	422	36%	37%	40%
2 people	473	40%	42%	31%
3 people	97	8.2%	8.6%	14%
4 people	77	6.5%	6.8%	9.7%
5+ people	61	5.2%	5.4%	6.1%
No answer	48	4.1%		

Error! Reference source not found. shows the respondents' residence types. Available population data from the American Community Survey divided households into renter and non-renter, therefore Targeted Marketing data was used for comparison instead. However, even the Targeted Marketing data only divided households into single-family and multi-family. The sample and population are relatively similar in terms of residence types.

Table 8 Survey Respondents' Residence Types (N=1,174)

	Residence Type	Responses	% of Respondents	% in Targeted Marketing Database
Single-family	Detached	759	64%	68%
	Duplex	84	7.1%	
Multi-family	Apt	310	26%	32%
	Other	21	1.8%	

In addition to the household level demographics, individual demographic questions were asked in the final section of the survey. For these demographics, a similar comparison to the populations from which the respondents belong is included. **Error! Reference source not found.** includes the gender of the survey respondents. We found that the list of addressees in the study areas apparently have substantially more females than males, according to the Targeted Marketing data, so in this case a comparison to Targeted Marketing data is provided to show the comparison to the genders of the study invitees. Note that the Targeted Marketing database is binary for gender, so those responding with "Prefer not to answer" and "Other" were combined for comparison to the population. Even given the preference to females in the invitation list, the survey respondents appear to be skewed even more heavily toward females.

Table 9 Survey Respondents' Genders (N=1,149, P<0.001)

Gender	Responses	% of Respondents	% of Respondents Answering Question	% in Targeted Marketing Database
Female	698	59%	61%	55%
Male	443	38%	39%	40%
Prefer not to Answer / Other	8	0.7%		

Error! Reference source not found. shows the age ranges of survey respondents alongside those of the population. The small P-value indicates a divergence of the sample from the population, and visual inspection reveals respondents tended to be older than the population of the combined study areas, which is typical in surveys like this one. The average age of the survey respondents was 52 years old.

Table 10 Survey Respondents' Ages (N=1,113, P<0.001)

Age	Responses	% of Respondents	% of Respondents Answering Question	% Population from ACS
18-34	204	17%	18%	40%
35-49	214	18%	19%	21%
50-64	378	32%	34%	23%
65+	317	27%	28%	16%

Error! Reference source not found. shows the race of survey respondents. The majority of respondents were white, although substantial portions were African-American as well. However, the overrepresentation of whites by 20% is substantial and will be considered for weighting in future models. Note that representation of American Indians /

Native Americans and Asians/ Pacific Islanders was small in the ACS data, and these groups were combined with the "Other" category.

Table 11 Survey Respondents' Races (N=1,145, P<0.001)

Race	Responses	% of Respondents	% of Respondents Answering Question	% Population from ACS
American Indian / Native American	32	2.7%	2.8%	
Asian / Pacific Islander	16	1.4%	1.4%	
Hispanic / Latino	9	0.8%	0.8%	4.6%
Black / African American	312	26%	27%	52%
White / Caucasian	771	65%	67%	43%
Other	19	1.6%	1.7%	4.6%

Individual demographics questions were also asked that we are not able to compare to the populations to which the respondents belong as this data was not available from the marketing firm where the household addresses were obtained or the American Community Survey (ACS). This section includes these individual-level demographics about the survey respondents.

The employment status of survey respondents is shown in **Error! Reference source not found.**. Many of the respondents either work full time or do not work (either unemployed or retirees). Note that for the remainder of these descriptive statistics in this section there is no readily available population data source for comparison.

Table 12 Survey Respondents' Employment Status (N=1144)

Employment Status	Responses	% of Respondents	% of Respondents Answering Question
Full time	493	42%	43%
Part time	148	13%	13%
2+ jobs	36	3.1%	3.1%
Homemaker	55	4.7%	4.8%
Don't work	445	38%	39%

Finally, a series of questions was asked about respondents' transportation characteristics, including the number of vehicles per household, number of bikes per household, number of licensed drivers per household, and daily and monthly mode usage. In addition to bike ownership and usage, bike confidence was asked as one measure of the possibility that a respondent would bike given different trip characteristics. All of these variables will be explored in greater depth in the future analysis.

Error! Reference source not found. shows the number of vehicles and bicycles owned by survey respondents side by side. Most households owned 1 or 2 vehicles, although a modest portion did not own a vehicle. Many households owned at least one bike; however, more than half did not own a bike.

Table 13 Number of Vehicles and Bikes Owned by Survey Respondents (N=1159)

Number of Vehicles	Responses	% of Respondents	Number of Bikes	Responses	% of Respondents
0	124	11%	0	618	53%
1	399	34%	1	240	21%
2	413	36%	2	163	14%
3	141	12%	3	69	6.0%
4	52	4.5%	4	33	2.8%
5	16	1.4%	5	13	1.1%
6	8	0.7%	6	15	1.3%
7+	6	0.5%	7+	8	0.7%

In terms of bike confidence, the largest percentage (39%) felt very confident in riding a bicycle with only 14% unable to ride and 17% not very confident. **Error! Reference source not found.** shows bicycling confidence percentages for the survey respondents.

Table 14 Respondents' Stated Bike Confidence Level (N=1113)

Bike Confidence	Responses	% of Respondents	% of Respondents Answering Question
Can't bicycle	163	14%	15%
Not very confident	203	17%	18%
Somewhat confident	282	24%	25%
Very confident	465	39%	42%

Finally, the reported monthly and daily mode usage (for any purpose) by respondents is shown in **Error! Reference source not found.**. Single-occupant vehicles (SOV) are used regularly by the majority of respondents, with 85% driving alone on at least a monthly basis and 51% on a daily basis. Another 15% are daily carpoolers, although 69% carpool at least once per month. A large portion walk for transportation at least monthly with 44%, and 9.7% indicated they walk for a daily mode of transportation. Biking is 12% on at least a monthly basis with only 1.4% being daily bicycle transportation users. Thus, we can have some confidence that the sample is not substantially skewed toward bicycling enthusiasts.

Table 15 Respondents' Monthly and Daily Mode Usage (N=1,178)

Mode	Monthly		Daily	
	Responses	% of Responses	Responses	% of Responses
SOV	1004	85%	595	51%
Carpool	814	69%	180	15%
Transit	122	10%	27	2.3%
Taxi	27	2.3%	5	0.4%
Uber	67	5.7%	2	0.2%
Bike	136	12%	17	1.4%
Walk	522	44%	114	9.7%

In summary, roughly half of respondents reported having at least one bicycle in their household. Additionally, 11% reported biking for utilitarian purposes to some degree, and nearly 20% reported cycling for recreation. However, only 1% of respondents reported daily utilitarian cycling. The discrepancy between the numbers of casual and regular cyclists provides a sizable portion of the sample that is already accustomed to cycling, but does not bike on a regular basis. Ongoing analysis focuses on this group and the role perceived safety plays in why these individuals choose not to cycle regularly.

4.6 Summary Statistics Separated by Study Area

The same household demographics were also separated by study area for comparison within each subpopulation. A breakdown of household incomes by study area is presented in **Error! Reference source not found.**. Note that the numbers of individuals who specified “Prefer not to Answer” were removed from this table to provide a more intuitive comparison to the population. As discussed earlier, individuals in higher income brackets were overrepresented in the combined study area. However, it appears that this is mostly the case in the urban areas of Chattanooga and Birmingham, and much less prevalent in the smaller communities.

Table 16 Household Incomes Separated by Study Area

Household Income	Anniston (N=152, P=0.358)			Opelika (N=146, P=0.025)			Chattanooga (N=196, P<0.001)		
	Sample		Population	Sample		Population	Sample		Population
$15,000 or less	43	28%	30%	26	18%	20%	39	20%	34%
$15,001 - $30,000	32	21%	24%	19	13%	21%	21	11%	23%
$30,001 - $50,000	27	18%	19%	23	16%	18%	27	14%	18%
$50,001 - $75,000	25	16%	16%	24	16%	16%	37	19%	11%
$75,001 - $100,000	7	4.6%	4.0%	23	16%	10%	20	10%	4.9%
$100,001 - $125,000	9	5.9%	2.9%	10	6.8%	6.2%	13	6.6%	4.2%
More than $125,000	9	5.9%	4.3%	21	14%	9.1%	39	20%	5.3%

Household Income	Talladega (N=76, P=0.121)			Northport (N=178, P<0.001)			Birmingham (N=228, P<0.001)		
	Sample		Population	Sample		Population	Sample		Population
$15,000 or less	19	25%	32%	13	7.3%	18%	39	17%	32%
$15,001 - $30,000	14	18%	21%	25	14%	26%	29	13%	22%
$30,001 - $50,000	18	24%	21%	30	17%	19%	26	11%	18%
$50,001 - $75,000	10	13%	15%	43	24%	20%	38	17%	11%
$75,001 - $100,000	7	9.2%	4.1%	32	18%	8.7%	29	13%	7.8%
$100,001 - $125,000	4	5.3%	2.7%	17	9.6%	3.6%	16	7.0%	4.3%
More than $125,000	4	5.3%	4.2%	18	10%	4.6%	51	22%	4.4%

Household size by study area is presented in **Error! Reference source not found.**. Most areas (excluding Opelika) had a significant P-value (at the $P<0.05$ level) for the goodness-of-fit test, with the bulk of the deviation occurring through the overrepresentation of 2-person households. Each area showed the pattern of overrepresentation of 2-person households, likely implying that couples are more likely to respond than singles or households with additional family members.

Table 17 Household Sizes by Study Area

Household Size	Anniston (N=189, P=0.020)			Opelika (N=173, P=0.335)			Chattanooga (N=217, P<0.001)		
	Sample		Population	Sample		Population	Sample		Population
1	71	38%	37%	48	28%	32%	80	37%	42%
2	78	41%	32%	72	42%	36%	96	44%	28%
3	20	11%	13%	23	13%	13%	12	5.5%	13%
4	13	6.9%	10%	15	8.7%	12%	17	7.8%	9.3%
5+	7	3.7%	7.6%	15	8.7%	6.9%	12	5.5%	6.9%

Household Size	Talladega (N=82, P=0.006)			Northport (N=220, P<0.001)			Birmingham (N=249, P<0.001)		
	Sample		Population	Sample		Population	Sample		Population
1	35	43%	33%	71	32%	39%	117	47%	55%
2	32	39%	31%	92	42%	32%	103	41%	25%
3	5	6.1%	16%	21	9.5%	18%	16	6.4%	12%
4	4	4.9%	14%	22	10%	7.8%	6	2.4%	4.5%
5+	6	7.3%	7.3%	14	6.4%	2.7%	7	2.8%	3.2%

Error! Reference source not found. shows the breakdown of residence types by study area compared to the targeted marketing population data. Opelika (and to a somewhat lesser extent, Northport) slightly more overrepresents responses from detached residences in comparison to other areas, but few major discrepancies arise.

Table 18 Residence Types by Study Area

Residence Type	Anniston (N=195)			Opelika (N=177)			Chattanooga (N=226)		
	Sample		TM* Data	Sample		TM* Data	Sample		TM* Data
Detached	157	81%	86%	143	81%	71%	116	51%	60%
Duplex	14	7.2%		9	5.1%		20	8.8%	
Apt	18	9.2%	14%	18	10%	29%	88	39%	40%
Other	6	3.1%		7	4.0%		2	0.9%	

Residence Type	Talladega (N=88)			Northport (N=220)			Birmingham (N=249)		
	Sample		TM* Data	Sample		TM* Data	Sample		TM* Data
Detached	76	86%	85%	163	72%	68%	104	40%	49%
Duplex	4	4.5%		17	7.6%		20	7.6%	
Apt	8	9.1%	15%	44	20%	32%	134	51%	51%
Other	0	0.0%		1	0.4%		5	1.9%	

*TM=Targeted Marketing

Responses for gender are compared to the population (from the targeted marketing data) for each area in **Error! Reference source not found.**. There were more females than males in each area according to the targeted marketing data, however, responses from each area were even more female-heavy. None of the P-values from the Chi-squared goodness-of-fit tests were significant for individual areas, even though it was for the combined study area. This likely implies that the deviance from the population is distributed among study areas and is only statistically perceivable for the combined population.

Table 19 Gender by Study Area

Gender	Anniston (N=190, P=0.577)			Opelika (N=177, P=0.254)			Chattanooga (N=220, P=0.148)		
	Sample		TM* Data	Sample		TM* Data	Sample		TM* Data
Female	114	60%	57%	112	63%	57%	131	60%	53%
Male	75	39%	39%	65	37%	38%	87	40%	42%

Gender	Talladega (N=82, P=0.074)			Northport (N=221, P=0.254)			Birmingham (N=259, P=0.136)		
	Sample		TM* Data	Sample		TM* Data	Sample		TM* Data
Female	55	67%	55%	143	65%	59%	143	55%	49%
Male	27	33%	40%	77	35%	36%	112	43%	45%

*TM=Targeted Marketing

Age distributions compared to populations of each area compared to ACS population data are presented in **Error! Reference source not found.**. Across all study areas there was a greater response rate among senior citizens (over 65), though both Chattanooga and Birmingham had overall lower shares of senior citizens responding than did the more rural areas.

Table 20 Age Distribution by Study Area

Age	Anniston (N=184, P<0.001)			Opelika (N=171, P<0.001)			Chattanooga (N=212, P<0.001)		
	Responses		Population	Responses		Population	Responses		Population
18-34	15	8.2%	29%	23	13%	30%	40	19%	46%
35-49	29	16%	21%	41	24%	22%	49	23%	21%
50-64	64	35%	30%	62	36%	28%	79	37%	21%
65+	76	41%	20%	45	26%	20%	44	21%	12%

Age	Talladega (N=80, P<0.001)			Northport (N=215, P<0.001)			Birmingham (N=251, P<0.001)		
	Responses		Population	Responses		Population	Responses		Population
18-34	8	10%	32%	46	21%	40%	72	29%	52%
35-49	10	13%	25%	40	19%	18%	45	18%	19%
50-64	27	34%	26%	69	32%	21%	77	31%	17%
65+	35	44%	17%	60	28%	20%	57	23%	11%

The racial breakdown of respondents by area is presented in **Error! Reference source not found.**. There was a heavy overrepresentation of white respondents in each area. White / Caucasian was the most common reported race in each area, even though it is not the most common in most areas according to population data from ACS. Opelika and Northport both appeared to have the greatest portion of White / Caucasian according to ACS and survey responses. Note that since respondents can be described as multiple races, percentages may exceed 100.

Table 21 Race Distribution by Study Area

Race	Anniston (N=189, P<0.001)			Opelika (N=175, P<0.001)			Chattanooga (N=220, P<0.001)		
	Sample		Population	Sample		Population	Sample		Population
American Indian / Native American	5	2.6%		6	3.4%		6	2.7%	
Asian / Pacific Islander	1	0.5%		2	1.1%		1	0.5%	
Hispanic / Latino	1	0.5%		0	0.0%		3	1.4%	
Black / African American	80	42%	61%	47	27%	51%	64	29%	52%
White / Caucasian	96	51%	36%	123	70%	45%	144	65%	43%
Other	3	1.6%	5.0%	2	1.1%	7.9%	6	2.7%	11%

Table 21 Race Distribution by Study Area (continued)

Race	Talladega (N=84, P<0.001)			Northport (N=218, P<0.001)			Birmingham (N=259, P<0.001)		
	Sample		Population	Sample		Population	Sample		Population
American Indian / Native American	3	3.6%		4	1.8%		8	3.1%	
Asian / Pacific Islander	0	0.0%		1	0.5%		11	4.2%	
Hispanic / Latino	0	0.0%		3	1.4%		2	0.8%	
Black / African American	27	32%	57%	24	11%	39%	70	27%	53%
White / Caucasian	54	64%	40%	182	83%	56%	172	66%	41%
Other	1	1.2%	11%	3	1.4%	9.3%	4	1.5%	11%

The employment status breakdown for each area is presented in **Error! Reference source not found.**. By inspection, Anniston and Talladega had larger portions of individuals who don't work, consistent with the earlier findings of higher portions of individuals in retirement age (over 65).

Table 22 Employment Status by Study Area

Employment Status	Anniston (N=188)		Opelika (N=173)		Chattanooga (N=220)	
Full time	44	23%	69	40%	108	49%
Part time	23	12%	28	16%	34	15%
2+ jobs	5	2.7%	8	4.6%	5	2.3%
Homemaker	14	7.4%	8	4.6%	13	5.9%
Don't work	107	57%	66	38%	66	30%

Employment Status	Talladega (N=83)		Northport (N=222)		Birmingham (N=258)	
Full time	22	27%	106	48%	144	56%
Part time	9	11%	35	16%	19	7%
2+ jobs	2	2.4%	6	2.7%	10	3.9%
Homemaker	4	4.8%	11	5.0%	5	1.9%
Don't work	47	57%	71	32%	88	34%

Vehicle ownership data for each area is presented in **Error! Reference source not found.**. Opelika and Northport had greater portions of respondents with at least one vehicle.

Table 23 Number of Vehicles and Bikes Owned by Study Area

Vehicles per Household	Anniston (N=190)		Opelika (N=175)		Chattanooga (N=220)	
0	24	13%	12	7%	32	15%
1	71	37%	46	26%	69	31%
2	60	32%	74	42%	81	37%
3	20	11%	25	14%	23	10%
4	10	5.3%	12	6.9%	8	3.6%
5+	5	2.6%	6	3.4%	7	3.2%

Vehicles per Household	Talladega (N=87)		Northport (N=222)		Birmingham (N=265)	
0	11	13%	10	4.5%	35	13%
1	30	34%	78	35%	105	40%
2	25	29%	81	36%	92	35%
3	15	17%	37	17%	21	7.9%
4	0	0.0%	14	6.3%	8	3.0%
5+	6	6.9%	2	0.9%	4	1.5%

Bicycle ownership for each area is represented in **Error! Reference source not found.**. Chattanooga had fewer households without access to a bike, even compared to its control area of Birmingham.

Table 24 Number of Vehicles and Bikes Owned by Study Area

Bikes per Household	Anniston (N=191)		Opelika (N=173)		Chattanooga (N=219)	
0	114	60%	93	54%	95	43%
1	36	19%	34	20%	43	20%
2	24	13%	21	12%	41	19%
3	12	6.3%	11	6.4%	17	7.8%
4	3	1.6%	6	3.5%	12	5.5%
5+	2	1.0%	8	4.6%	11	5.0%

Bikes per Household	Talladega (N=88)		Northport (N=223)		Birmingham (N=265)	
0	58	66%	118	53%	140	53%
1	12	14%	46	21%	69	26%
2	10	11%	31	14%	36	14%
3	4	4.5%	12	5.4%	13	4.9%
4	2	2.3%	9	4.0%	1	0.4%
5+	2	2.3%	7	3.1%	6	2.3%

Respondents' stated bike confidence levels are tabulated in **Error! Reference source not found.**. The smaller areas (Anniston and Talladega) had larger portions of those who can't bike, while the more urban areas (Chattanooga and Birmingham) had larger portions of those reporting as "very confident". There is somewhat of a discrepancy between each treatment area and their respective control area, as each treatment area has a larger portion of respondents who cannot bike.

Table 25 Respondents' Stated Bike Confidence Level by Study Area

Bike Confidence	Anniston (N=182)		Opelika (N=171)		Chattanooga (N=215)	
Can't Bike	48	26%	26	15%	30	14%
Not Very Confident	29	16%	34	20%	36	17%
Somewhat Confident	36	20%	47	27%	49	23%
Very Confident	69	38%	64	37%	100	47%

Bike Confidence	Talladega (N=79)		Northport (N=212)		Birmingham (N=254)	
Can't Bike	17	22%	21	10%	21	8.3%
Not Very Confident	21	27%	41	19%	42	17%
Somewhat Confident	15	19%	67	32%	68	27%
Very Confident	26	33%	83	39%	123	48%

4.7 Summary Statistics Segmented by Rider Status

The same household characteristics were also computed based on segments of different rider status among the combined study group. The four rider statuses are potential rider, recreational, utilitarian, and those that cannot bike. The criteria for inclusion in one of these categories comes from the responses to questions regarding bicycling confidence, cycling distances for recreation/utilitarian purpose, and cycling trip frequency for commute/other purposes. The 4 segments and their criteria are:

1. Potential cyclist (N=700)—those who report zero miles of cycling per month, but report being able to ride a bike, regardless of confidence level.
2. Recreational cyclist (N=166)—those who bike a non-zero distance per month, but bike less than once a month *and* less than a mile a week, on average, for utilitarian purposes.
3. Utilitarian cyclist (N=84)—those who bike at least once a month *or* at least a mile a week, on average, for utilitarian purposes.
4. Cannot bike (N=163)—those who state that they cannot ride a bicycle.

The statistics presented do not have a comparison to the population, as there is no readily available population-level data for rider type segmentation. Note that those who did not answer the bike confidence question were not able to be included in the segmentation.

Income for each of these segments is presented in **Error! Reference source not found.**. Household income for both current cyclist groups tended to be much higher, while those that cannot bike were overrepresented in the lower income categories.

Table 26 Household Income Distribution by Rider Status

Household Income	Potential (N=583)		Recreational (N=144)		Utilitarian (N=76)		Cannot Bike (N=126)	
$15,000 or less	85	15%	15	10%	11	14%	51	40%
$15,001 - $30,000	79	14%	9	6.3%	7	9.2%	37	29%
$30,001 - $50,000	98	17%	21	15%	11	14%	10	7.9%
$50,001 - $75,000	121	21%	27	19%	14	18%	13	10%
$75,001 - $100,000	79	14%	18	13%	4	5.3%	10	7.9%
$100,001 - $125,000	45	7.7%	16	11%	6	7.9%	2	1.6%
More than $125,000	76	13%	38	26%	23	30%	3	2.4%

Distributions for household sizes by rider type are presented in Table 27. Single-person households were overrepresented in the group of individuals who cannot bike. Large households were overrepresented among both recreational and utilitarian cyclist groups.

Table 27 Household Size Distribution by Rider Status

Household Size	Potential (N=680)		Recreational (N=162)		Utilitarian (N=82)		Cannot Bike (N=152)	
1	239	35%	48	30%	27	33%	77	51%
2	300	44%	66	41%	35	43%	57	38%
3	62	9.1%	20	12%	3	3.7%	8	5.3%
4	46	6.8%	14	8.6%	10	12%	4	2.6%
5+	33	4.9%	14	8.6%	7	8.5%	6	3.9%

Residence types for each rider type are presented in Table 28. Utilitarian cyclists were less likely to live in a detached residence, indicating that there may be a linkage between utilitarian cycling and urban environment.

Table 28 Residence Type Distribution by Rider Status

Residence Type	Potential (N=698)		Recreational (N=165)		Utilitarian (N=84)		Cannot Bike (N=162)	
Detached	468	67%	113	68%	41	49%	99	61%
Apt	42	6.0%	11	6.7%	9	11%	13	8.0%
Duplex	180	26%	40	24%	32	38%	42	26%
Other	8	1.1%	1	0.6%	2	2.4%	8	4.9%

Responses for gender are reported by rider type in Table 29. Females were overrepresented in both non-rider groups. Recreational cyclists were closer to an even split (despite the pooled sample being predominantly female), and a majority of utilitarian cyclists were male.

Table 29 Gender Distribution by Rider Status

Gender	Potential (N=693)		Recreational (N=166)		Utilitarian (N=84)		Cannot Bike (N=161)	
Male	261	38%	79	48%	49	58%	39	24%
Female	426	61%	85	51%	35	42%	122	76%
Other / Prefer not to specify	6	0.9%	2	1.2%	0	0.0%	0	0.0%

Respondents' ages for each rider type are presented in Table 30. Not surprisingly, a large part of those who cannot bike are those 65 years old or older. Utilitarian cyclists are likewise more likely to be under 35. Little variation is noted between the age distributions for potential and recreational cyclists.

Table 30 Age Distribution by Rider Status

Age	Potential (N=675)		Recreational (N=161)		Utilitarian (N=83)		Cannot Bike (N=153)	
<35	130	19%	35	22%	32	39%	6	3.9%
35-49	132	20%	43	27%	21	25%	14	9.2%
50-64	221	33%	53	33%	27	33%	61	40%
65+	192	28%	30	19%	3	3.6%	72	47%

Respondents' race by rider type is presented in Table 31. African-Americans appeared to be overrepresented in the group of those who cannot bike, while utilitarian cyclists appeared to be overrepresented by Caucasians.

Table 31 Race Distribution by Rider Status

Race	Potential (N=692)		Recreational (N=163)		Utilitarian (N=83)		Cannot Bike (N=161)	
American Indian / Native American	16	2.3%	4	2.5%	4	4.8%	7	4.3%
Asian / Pacific Islander	7	1.0%	3	1.8%	5	6.0%	1	0.6%
Hispanic / Latino	6	0.9%	1	0.6%	1	1.2%	1	0.6%
Black / African American	176	25%	34	21%	8	10%	70	43%
White / Caucasian	487	70%	120	74%	67	81%	79	49%
Other	13	1.9%	2	1.2%	1	1.2%	2	1.2%

Table 32 shows the employment status breakdown for each rider type group. As expected with the overrepresentation of senior adults in the cannot bike category, a majority of those in that category do not work. Utilitarian cyclists were also much more likely to work full-time.

Table 32 Employment Status Distribution by Rider Status

Employment Status	Potential (N=692)		Recreational (N=165)		Utilitarian (N=83)		Cannot Bike (N=161)	
Full time	318	46%	96	58%	55	66%	21	13%
Part time	98	14%	17	10%	13	16%	13	8.1%
2+ jobs	19	2.7%	7	4.2%	6	7.2%	2	1.2%
Homemaker	27	3.9%	11	6.7%	3	3.6%	14	8.7%
Don't work	245	35%	42	25%	11	13%	113	70%

Vehicle and bike ownership broken down by rider types are presented in Table 33. Zero-vehicle households were overrepresented in the group of those who cannot bike, pointing to a double transportation disadvantage for those households. Households with three or more vehicles were overrepresented in the potential and recreational rider groups, indicating that both utilitarian cyclists and those who cannot bike are less likely to own many vehicles. Interestingly, five utilitarian cyclists report not owning a bike. Four of the five reported elsewhere in the survey that they are current users of bikeshare, while the fifth reported using bikeshare in the past.

Table 33 Number of Vehicles and Bikes Owned by Rider Status

Vehicles per Household	Potential (N=693)		Recreational (N=164)		Utilitarian (N=83)		Cannot Bike (N=161)	
0	60	8.7%	9	5.5%	8	10%	33	20%
1	224	32%	48	29%	29	35%	72	45%
2	256	37%	69	42%	34	41%	43	27%
3	99	14%	22	13%	6	7.2%	10	6.2%
4	33	4.8%	10	6.1%	5	6.0%	2	1.2%
5+	21	3.0%	6	3.7%	1	1.2%	1	0.6%

Bikes per Household	Potential (N=695)		Recreational (N=164)		Utilitarian (N=82)		Cannot Bike (N=161)	
0	413	59%	14	8.5%	5	6.1%	137	85%
1	137	20%	59	36%	24	29%	16	10%
2	86	12%	47	29%	23	28%	5	3.1%
3	29	4.2%	23	14%	14	17%	2	1.2%
4	17	2.4%	8	4.9%	8	9.8%	0	0.0%
5+	13	1.9%	13	7.9%	8	9.8%	1	0.6%

Table 34 shows respondents' stated level of bike confidence, segmented by rider type. By definition, all those who state they cannot bike are in the category of "cannot bike." Respondents of all confidence levels were present in the potential rider group. There are higher representations of more confident riders in both the recreational and utilitarian groups.

Table 34 Respondent's Stated Level of Bike Confidence by Rider Status

Confidence Level	Potential (N=700)		Recreational (N=166)		Utilitarian (N=84)		Cannot Bike (N=163)	
Can't Bike	0	0%	0	0%	0	0%	163	100%
Not Very Confident	195	28%	8	4.8%	0	0%	0	0%
Somewhat Confident	234	33%	36	22%	12	14%	0	0%
Very Confident	271	39%	122	73%	72	86%	0	0%

4.8 Summary

A 12-page survey was administered to residents of six communities. The survey included sections about attitudes, travel, bicycle experiences and preferences, and sociodemographics. The intent of the survey was to explore the root factors influencing bicycle preferences. A sample of 1,223 responses was used to explore different characteristics for the combined study area as well as differences between sites and rider types. Respondents were also presented with a series of infrastructure images and asked to rate their preferences. A further analysis of these stated preferences is included in the next chapter.

CHAPTER 5. USER PREFERENCE ANALYSIS

5.1 Infrastructure Images

The images presented to respondents were created in Adobe Photoshop. One common roadway setting was chosen as a base image to control for urban environment, weather, and other contextual variables. Variations were made based on different types of bicycle infrastructure, the presence or absence of on-street parking, and the number of automobile lanes. Each scenario exhibited a moderate amount of automobile traffic that would allow for near-free flow conditions with a reasonable amount of opportunity for auto-to-cyclist interactions. The images were designed such that the background scenery would be recognizable by both urban dwellers as an in-town neighborhood and rural dwellers as a small town.

Seventeen total images were prepared, shown in Figure 6 and Figure 7. The infrastructure includes sharrows, bike lanes, buffered bike lanes, and barrier-protected bike lanes (also referred to as separated bike lanes). Two of the protected bike lanes were one-way, while the other two were two-way. An image for a multi-use path was also created, though due to the nature of this type of infrastructure a different road environment had to be used.

For each image, respondents were given the prompt: "Bicycling on a road [trail] like this is…". They were presented with a 5-point Likert-type scale (Strongly disagree, Disagree, Neutral or No opinion, Agree, or Strongly agree) and asked to choose the response most appropriate for each of three perceptions: "Comfortable", "Safe", and

“Something I’d try”. Respondents were randomly assigned one of four versions, each of which had a different combination of infrastructure images. Each version had a base road configuration (e.g., two lanes with on-street parking, or four lanes with no parking) for which a sequence of all four on-street infrastructure types were shown. Two other images were also included, from among the other road configurations and/or multi-use trails, so each respondent was presented with six infrastructure combinations, and several were repeated between surveys.

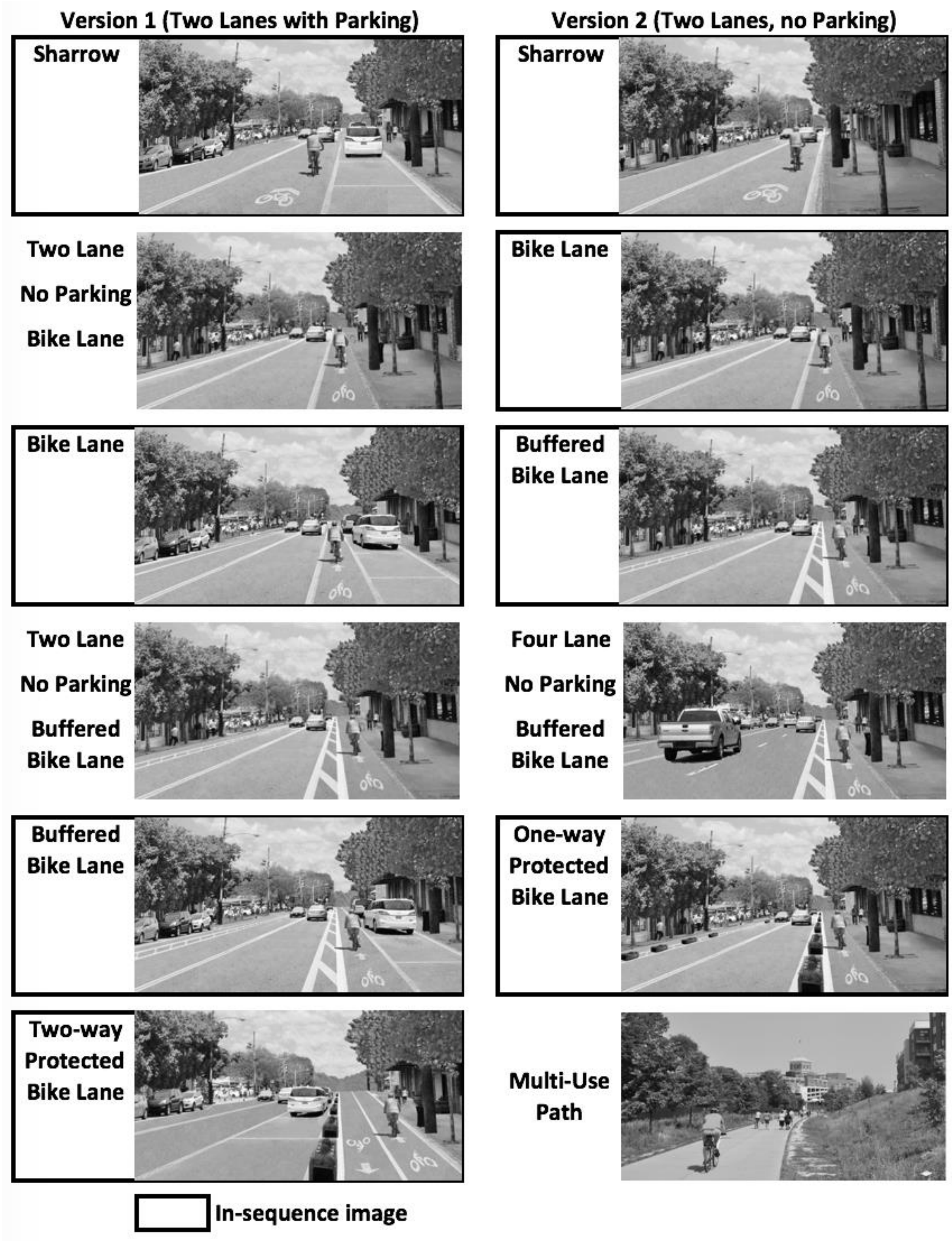


Figure 6 Combinations of bicycle infrastructure used in survey versions 1 and 2.

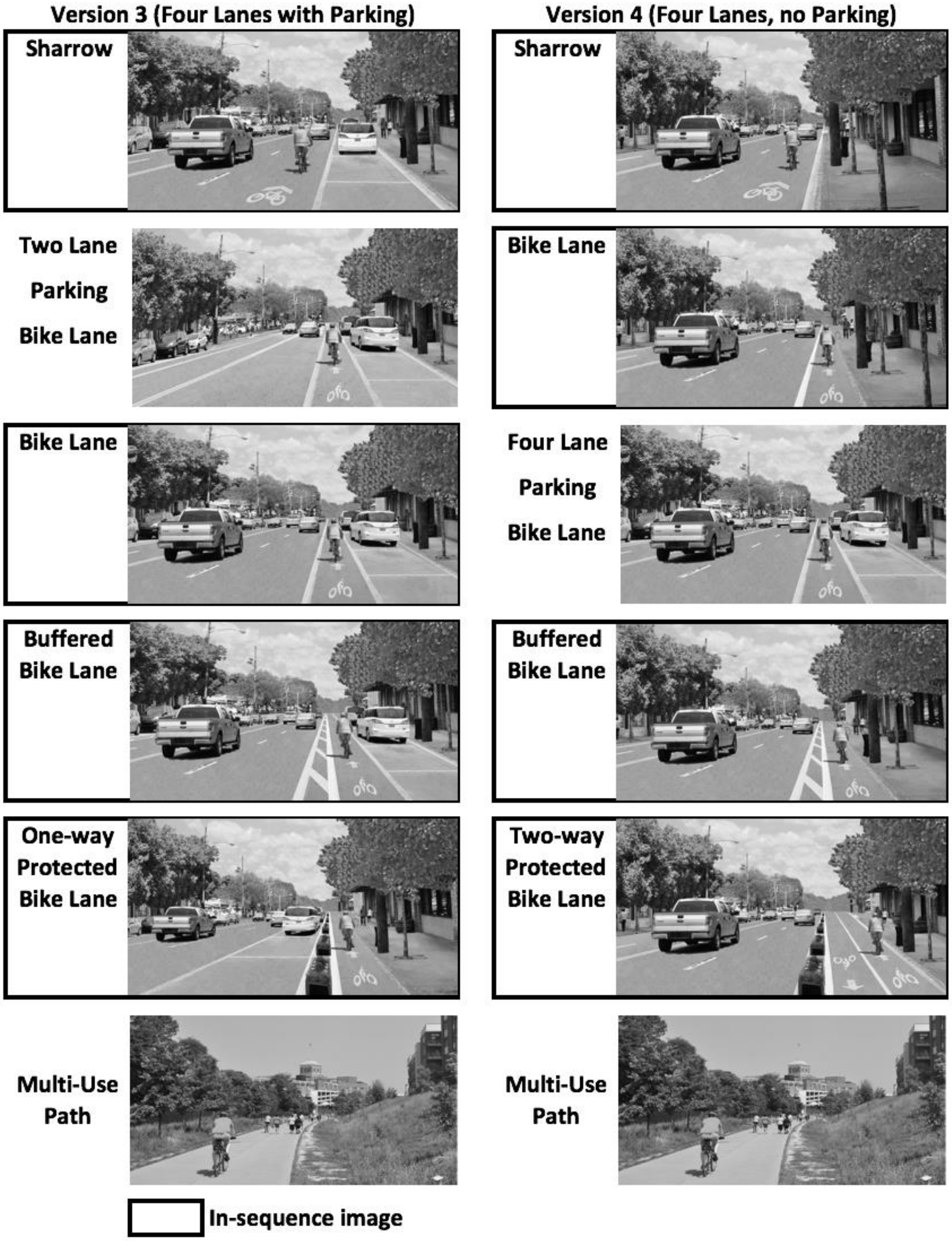


Figure 7 Combinations of bicycle infrastructure used in survey versions 3 and 4.

5.2 Image Response Results

Each respondent was presented with six images of bicycling infrastructure, and asked to rate their perceptions of bicycling on the infrastructure in terms of "Comfortable," "Safe," and "Something I'd try." The following discussion will compare responses to these statements for particular configurations and trends, using the average response presented in Table 35 as a baseline. Overall, and not surprisingly, respondents were generally more polarized about willingness to try than comfort and safety.

Table 35 Responses for Perceived Comfort, Safety, and Willingness to Try, Averaged across Infrastructure Types

	Comfortable	Safe	Would try
Sample size	6961	6952	6890
Strongly Disagree	9%	9%	16%
Disagree	13%	16%	13%
Neutral	22%	21%	18%
Agree	34%	33%	29%
Strongly Agree	21%	21%	24%

Multi-use paths were the most favorably viewed, as displayed in Table 36. Nearly half of respondents strongly agreed that the setup was comfortable and safe, and that they would try it. A very small percentage of respondents disagreed with those statements. Although survey respondents were not directly given the opportunity to explain their rationale, this data is consistent with the comments from the focus groups that the complete removal of vehicular traffic makes the infrastructure much less intimidating. It appears respondents would be more likely to try this type of infrastructure; however, the data does not reveal if they would be willing to ride fast (as for utilitarian purposes) with pedestrians present. In practice users may not eliminate such a corridor from their potential routes, but they may end up taking other links to avoid slowing for pedestrians.

Table 36 Responses for Perceived Comfort, Safety, and Willingness to Try Multi-use Path

	Comfortable	Safe	Would try
Sample size	884	882	878
Strongly Disagree	3%	2%	8%
Disagree	4%	5%	6%
Neutral	14%	13%	13%
Agree	34%	36%	29%
Strongly Agree	45%	44%	44%

Cycletracks were the next most positively viewed configuration across the board. Responses for cycletracks are presented in Table 37, Table 38, Table 39, and Table 40 for different variations of lane configurations. All cycletrack configurations were viewed less positively than multi-use trails, but were viewed either similarly to or more positively than all other configurations. In the absence of complete removal of vehicles, such as with a multi-use path, cycletracks appear to be the next best option, as they provide physical separation from vehicles. This also supports the claims from the focus groups that the primary concern of potential cyclists is interaction with vehicles.

Table 37 Responses for Perceived Comfort, Safety, and Willingness to Try Two-way Cycletrack on Two-lane Road with Parking

	Comfortable	Safe	Would try
Sample size	282	281	276
Strongly Disagree	5%	5%	13%
Disagree	5%	5%	7%
Neutral	21%	19%	20%
Agree	33%	36%	26%
Strongly Agree	36%	35%	34%

Table 38 Responses for Perceived Comfort, Safety, and Willingness to Try One-way Cycletrack on Two-lane Road without Parking

	Comfortable	Safe	Would try
Sample size	310	309	303
Strongly Disagree	2%	3%	13%
Disagree	3%	2%	4%
Neutral	16%	14%	14%
Agree	38%	43%	32%
Strongly Agree	40%	39%	38%

Table 39 Responses for Perceived Comfort, Safety, and Willingness to Try One-way Cycletrack on Four-lane Road with Parking

	Comfortable	Safe	Would try
Sample size	298	299	292
Strongly Disagree	2%	2%	8%
Disagree	2%	2%	7%
Neutral	15%	12%	12%
Agree	41%	39%	34%
Strongly Agree	39%	45%	39%

Table 40 Responses for Perceived Comfort, Safety, and Willingness to Try Two-way Cycletrack on Four-lane Road without Parking

	Comfortable	Safe	Would try
Sample size	272	270	270
Strongly Disagree	4%	4%	9%
Disagree	6%	5%	12%
Neutral	16%	17%	15%
Agree	39%	36%	30%
Strongly Agree	36%	39%	34%

Among the more vulnerable configurations, where there was no physical separation from vehicles, the next most favorable was a buffered bike lane on a two-lane road without parking, as presented in

Table 41. This finding is consistent with the hypotheses raised from the focus groups that two lanes are more favorable than four, parking makes it worse, and more distance from cars is better. This scenario is the most ideal according to these hypotheses and ends up floating to the top of the scenarios with no physical separation.

Table 41 Responses for Perceived Comfort, Safety, and Willingness to Try Buffered Bike Lane on Two-lane Road without Parking

	Comfortable	Safe	Would try
Sample size	590	589	583
Strongly Disagree	3%	3%	13%
Disagree	6%	6%	7%
Neutral	21%	21%	16%
Agree	44%	44%	35%
Strongly Agree	27%	26%	29%

Other configurations that were more favorable than average were bike lanes on two-lane and four-lane roads, presented in Table 42 and Table 43, respectively. Four-lane buffered bike lanes were slightly more favorable than average, as shown in Table 44.

Table 42 Responses for Perceived Comfort, Safety, and Willingness to Try Bike Lane on Four-lane Road without Parking

	Comfortable	Safe	Would try
Sample size	269	269	266
Strongly Disagree	5%	7%	15%
Disagree	9%	14%	11%
Neutral	28%	23%	18%
Agree	43%	42%	37%
Strongly Agree	16%	14%	18%

Table 43 Responses for Perceived Comfort, Safety, and Willingness to Try Bike Lane on Two-lane Road without Parking

	Comfortable	Safe	Would try
Sample size	593	588	588
Strongly Disagree	4%	5%	16%
Disagree	10%	14%	9%
Neutral	26%	27%	17%
Agree	47%	42%	38%
Strongly Agree	14%	12%	19%

Table 44 Responses for Perceived Comfort, Safety, and Willingness to Try Buffered Bike Lane on Four-lane Road without Parking

	Comfortable	Safe	Would try
Sample size	575	575	569
Strongly Disagree	4%	5%	13%
Disagree	8%	12%	12%
Neutral	26%	24%	20%
Agree	41%	40%	32%
Strongly Agree	20%	19%	23%

It is worth noting that, other than cycletrack scenarios, no configurations with parking were viewed favorably. This appears to be the most consistent variable in predicting respondents' reactions in terms of comfort, safety, and willingness to try each infrastructure. Additional quantitative analysis will be conducted to reveal the significance of this variable. All sharrows were viewed less favorably than average. Table 45,

Table 46, Table 47, and

Table 48 show the responses for sharrows on a two-lane road without parking, a two-lane road with parking, a four-lane road without parking, and a four-lane road with parking, respectively.

Table 45 Responses for Perceived Comfort, Safety, and Willingness to Try Sharrow on Two-lane Road without Parking

	Comfortable	Safe	Would try
Sample size	307	306	306
Strongly Disagree	15%	20%	27%
Disagree	26%	34%	18%

Neutral	27%	20%	16%
Agree	24%	19%	26%
Strongly Agree	8%	7%	13%

Table 46 Responses for Perceived Comfort, Safety, and Willingness to Try Sharrow on Two-lane Road with Parking

	Comfortable	Safe	Would try
Sample size	285	283	279
Strongly Disagree	17%	23%	28%
Disagree	31%	35%	18%
Neutral	24%	19%	20%
Agree	22%	17%	23%
Strongly Agree	6%	6%	12%

Table 47 Responses for Perceived Comfort, Safety, and Willingness to Try Sharrow on Four-lane Road without Parking

	Comfortable	Safe	Would try
Sample size	272	271	269
Strongly Disagree	18%	24%	27%
Disagree	28%	37%	26%
Neutral	26%	17%	17%
Agree	22%	18%	22%
Strongly Agree	6%	4%	9%

Table 48 Responses for Perceived Comfort, Safety, and Willingness to Try Sharrow on Four-lane Road with Parking

	Comfortable	Safe	Would try
Sample size	302	301	299
Strongly Disagree	15%	21%	25%
Disagree	28%	32%	23%

Neutral	26%	24%	18%
Agree	22%	17%	23%
Strongly Agree	9%	6%	10%

It is worth noting that the presence of parking, and the presence of a sharrow were rather consistent predictors in the configurations respondents view as less favorable. The only exception is the four-lane parking buffered bike lane scenario, which was right on the average, as presented in Table 49. Additional quantitative analysis will be necessary to explore the reasoning for this anomaly.

Table 49 Responses for Perceived Comfort, Safety, and Willingness to Try Buffered Bike Lane on Four-lane Road with Parking

	Comfortable	Safe	Would try
Sample size	297	299	292
Strongly Disagree	6%	6%	14%
Disagree	9%	11%	10%
Neutral	22%	19%	19%
Agree	41%	43%	32%
Strongly Agree	22%	21%	25%

Other trends within the subgroup of infrastructure configurations with parking are likely subtler. This further supports the hypothesis that the presence of parking is the driving factor for perceptions of potential cyclists. Additional quantitative analysis will be needed to identify other trends. For the sake of completeness in this report, the responses to the remaining configurations of bike lane on four-lane road with parking, buffered bike lane on two-lane road with parking, and bike lane on two-lane road with parking are presented in Table 50,

Table 51, and

Table 52, respectively.

Table 50 Responses for Perceived Comfort, Safety, and Willingness to Try Bike Lane on Four-lane Road with Parking

	Comfortable	Safe	Would try
Sample size	570	568	565
Strongly Disagree	13%	14%	19%
Disagree	25%	26%	28%
Neutral	29%	28%	23%
Agree	26%	26%	22%
Strongly Agree	7%	6%	8%

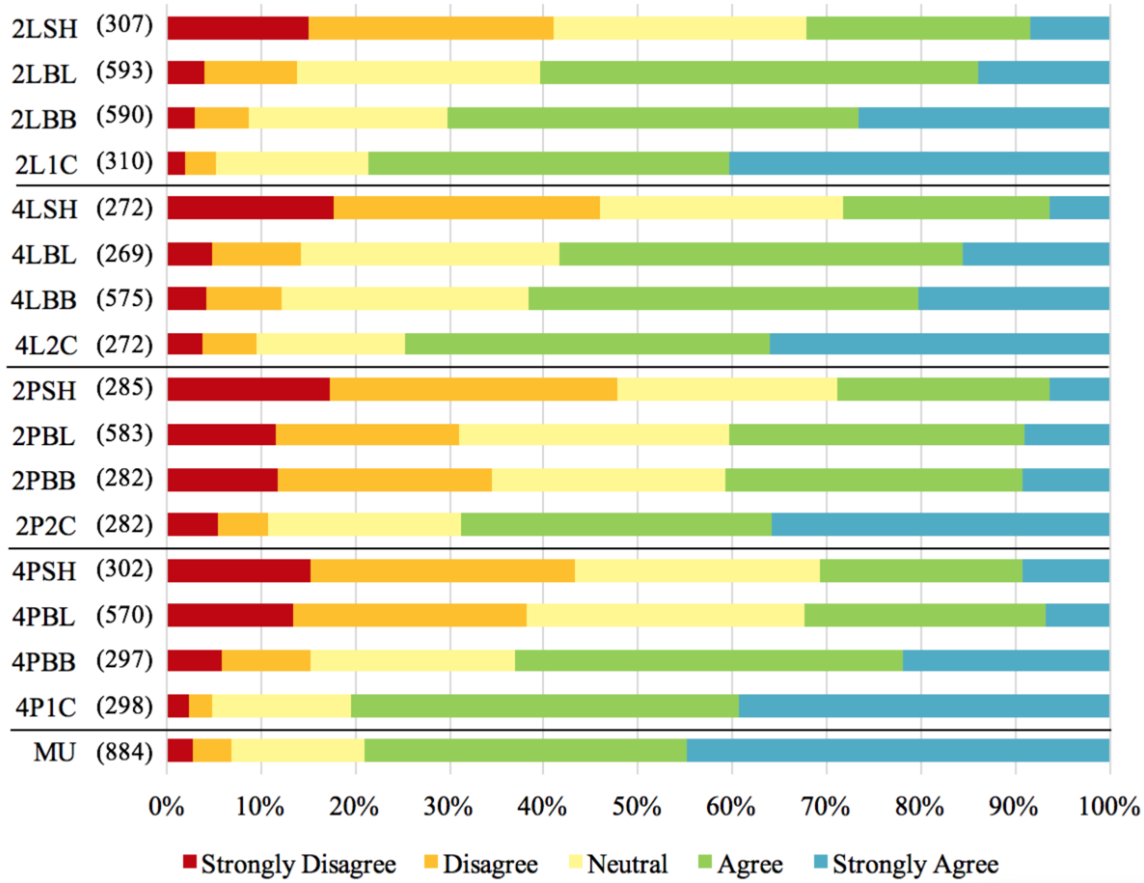
Table 51 Responses for Perceived Comfort, Safety, and Willingness to Try Buffered Bike Lane on Two-lane Road with Parking

	Comfortable	Safe	Would try
Sample size	282	281	279
Strongly Disagree	12%	14%	22%
Disagree	23%	26%	18%
Neutral	25%	27%	22%
Agree	32%	25%	25%
Strongly Agree	9%	7%	13%

Table 52 Responses for Perceived Comfort, Safety, and Willingness to Try Bike Lane on Two-lane Road with Parking

Comfortable		Safe	Would try
Sample size	583	581	576
Strongly Disagree	11%	14%	21%
Disagree	20%	25%	15%
Neutral	29%	27%	22%
Agree	31%	27%	27%
Strongly Agree	9%	8%	14%

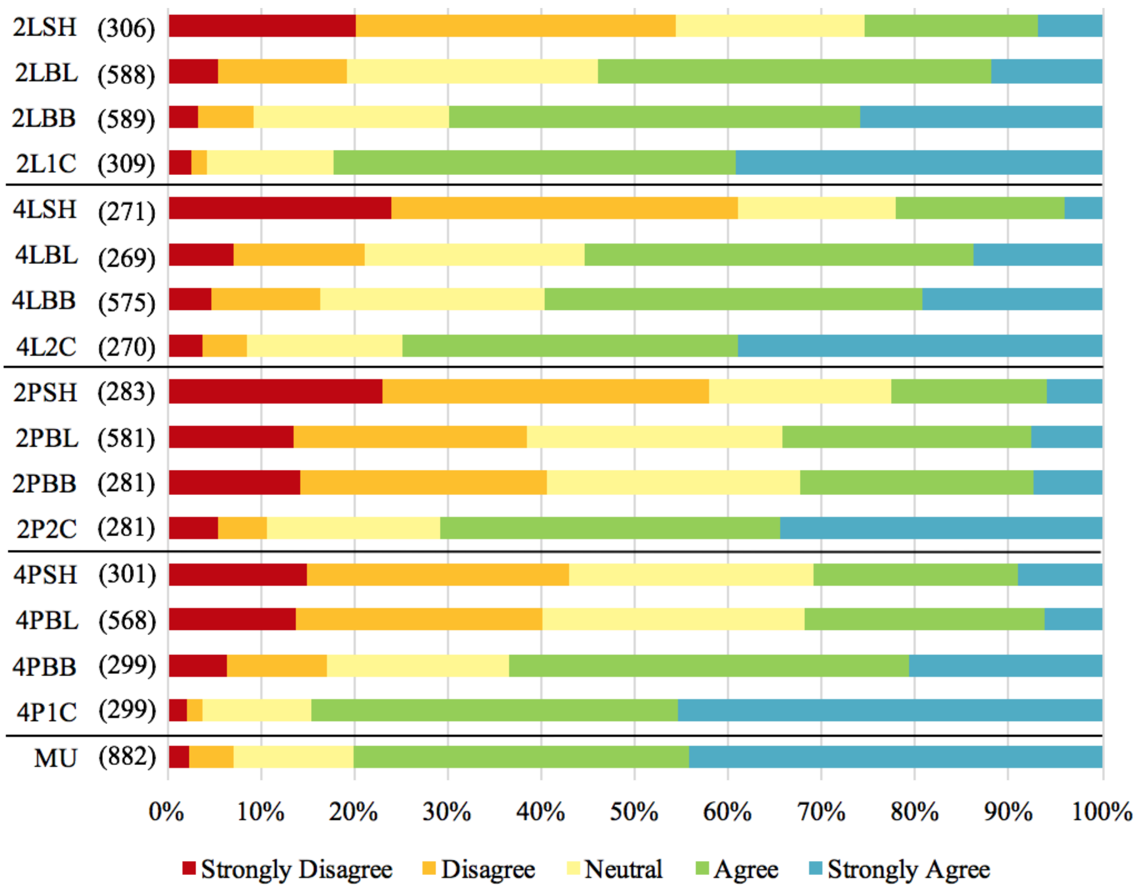
Figure 8, Figure 9, Figure 10, also show the same percentages visually for comfort, safety, and willingness to try, respectively. These figures are grouped so that for each lane combination each row is progressively more separated from traffic. The agreement with each perception clearly increases with each degree of separation from traffic, while there is a subtler decreasing trend of agreement with the addition of additional traffic lanes and on-street parking, though more rigorous analysis is necessary to address inconsistencies.



2L=two lanes, 4L=four lanes, 2P= two lanes with parking, 4P=four lanes with parking, SH=sharrow, BL=bike lane, BB=buffered bike lane, 1C=one-way protected cycletrack, 2C=two-way protected cycletrack, and MU=multi-use path.

*****number in parentheses is the number of responses for the associated configuration***

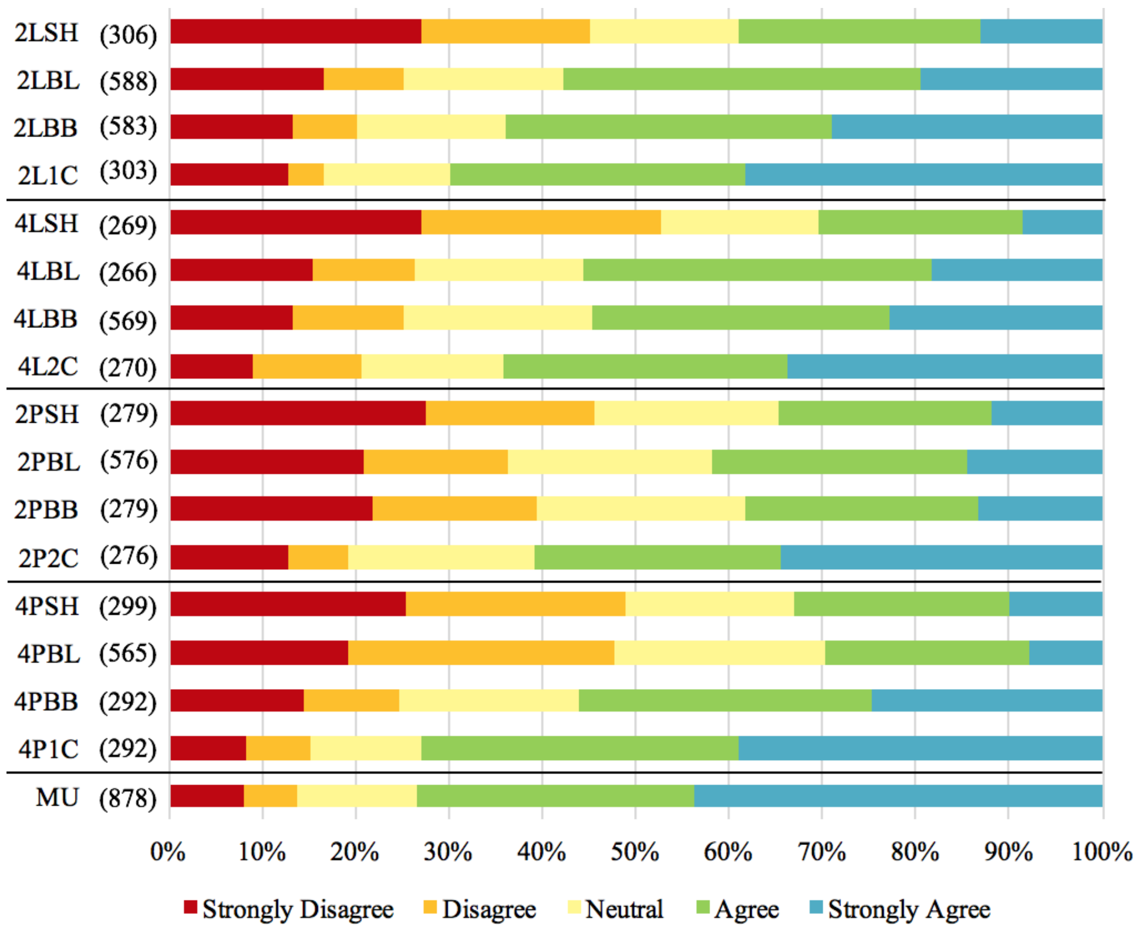
Figure 8 Distribution of Comfort Perceptions for Each Image



2L=two lanes, 4L=four lanes, 2P= two lanes with parking, 4P=four lanes with parking, SH=sharrow, BL=bike lane, BB=buffered bike lane, 1C=one-way protected cycletrack, 2C=two-way protected cycletrack, and MU=multi-use path.

*****number in parentheses is the number of responses for the associated configuration***

Figure 9 Distribution of Safety Perceptions for Each Image



2L=two lanes, 4L=four lanes, 2P= two lanes with parking, 4P=four lanes with parking, SH=sharrow, BL=bike lane, BB=buffered bike lane, 1C=one-way protected cycletrack, 2C=two-way protected cycletrack, and MU=multi-use path.

*****number in parentheses is the number of responses for the associated configuration***

Figure 10 Distribution of Willingness to Try Perceptions for Each Image

5.2.1 Frequency

Multi-use paths were the most frequently used out of all infrastructure types. The breakdown of reported frequency of biking on such a path is presented in Table 53. Roughly half of respondents had reported biking on something similar at least sometimes or often. This is likely a representation that even very casual cyclists are more likely to have biked on a multi-use path rather than on-street infrastructure. For example, many people will bike for a one-time recreational event, but never develop the habit. This type of ride is much more likely to take place on a multi-use path than any other type of infrastructure. Roughly 20% of the sample reported biking for recreation purposes, while only 13% bike for utilitarian purposes.

Table 53 Self-Reported Frequency of Use for Multi-use Paths

	Multi-use Path
Sample size	873
Never	48%
Sometimes	34%
Often	14%
Not Sure	4%

On-street facilities were biked less frequently. Table 54, Table 55, Table 56, and Table 57 display the reported frequencies for each infrastructure for two-lane roads without parking, two-lane roads with parking, four-lane roads without parking, and four-lane roads with parking, respectively.

Table 54 Self-Reported Frequency of Use for Each Infrastructure Type for Two-lane Roads without Parking

	Sharrow	Bike Lane	Buffered Bike Lane	One-way Cycletrack
Sample size	303	574	574	301
Never	70%	60%	75%	83%
Sometimes	21%	26%	14%	9%
Often	6%	9%	6%	6%
Not Sure	4%	5%	5%	3%

Table 55 Self-Reported Frequency of Use for Each Infrastructure Type for Two-lane Roads with Parking

	Sharrow	Bike Lane	Buffered Bike Lane	Two-way Cycletrack
Sample size	283	566	276	282
Never	67%	67%	80%	82%
Sometimes	19%	21%	10%	8%
Often	8%	8%	3%	4%
Not Sure	6%	5%	6%	6%

Table 56 Self-Reported Frequency of Use for Each Infrastructure Type for Four-lane Roads without Parking

	Sharrow	Bike Lane	Buffered Bike Lane	Two-way Cycletrack
Sample size	265	261	557	265
Never	71%	66%	83%	89%
Sometimes	20%	23%	10%	7%
Often	7%	9%	3%	2%
Not Sure	2%	2%	3%	2%

Table 57 Self-Reported Frequency of Use for Each Infrastructure Type for Four-lane Roads with Parking

	Sharrow	Bike Lane	Buffered Bike Lane	One-way Cycletrack
Sample size	298	561	296	293
Never	73%	77%	79%	82%
Sometimes	15%	14%	12%	10%
Often	8%	4%	3%	4%
Not Sure	4%	5%	5%	5%

5.3 User Preference Models

Survey respondents were presented with different configurations of roadway characteristics and infrastructure types, and asked to state their perceived level of comfort, safety, and willingness to try the presented infrastructure. Responses were converted to numeric values, with Strongly disagree equal to 1 and Strongly agree equal to 5. The average ratings for comfort, safety, and willingness to try are presented in Figure 11, Figure 12, and Figure 13, respectively. As mentioned previously, each version of the survey focused on the continuum of four infrastructure types within the same traffic lane and parking lane combination, plus two additional images duplicated from the other survey versions. To avoid the potential framing effects introduced by the insertion of these additional images "out of sequence", only the responses for the in-sequence images are included in the descriptive analysis presented here (sample size between 266 and 308 for each mean); all responses are included in the regression analysis reported below.

The characteristics of the bicycle infrastructure portion of the roadways for the sharrow, bike lane, and buffered bike lane cases were consistent between roadway configurations. However, protected bike lanes had two variations, one-way and two-way, only one of which was presented for a given configuration in order to limit the number of images presented. The broken lines on the graphs show the point in the progression of bicycle infrastructure where barrier-protection is introduced, and the two different protected bicycle infrastructure types are combined. The two-lane/no parking and four-lane with parking configurations had one-way protected bike lanes (indicated by the dashed line), while the four-lane/no parking and two-lane with parking ones had two-way protected bike lanes (indicated by the dash-dot lines). Given how tightly clustered the final groups of average ratings are, these figures indicate that the differences in mean ratings between protected bike lane scenarios may be largely unrelated to roadway characteristics, which is not necessarily surprising in view of their protected nature.

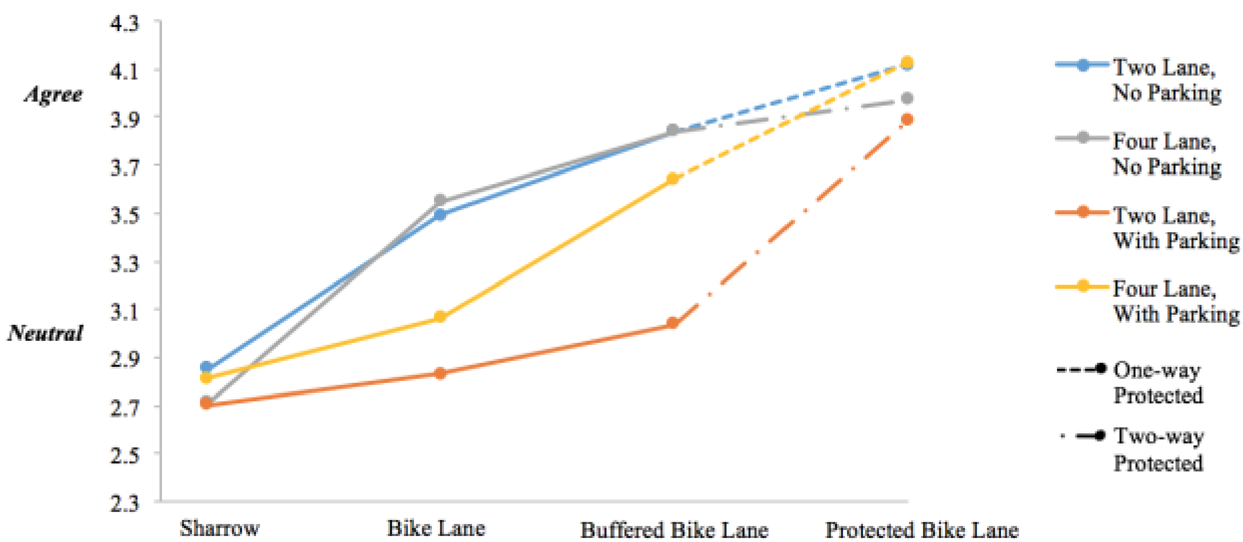


Figure 11 Average expressed comfort levels for each lane/parking configuration by bicycle infrastructure type.

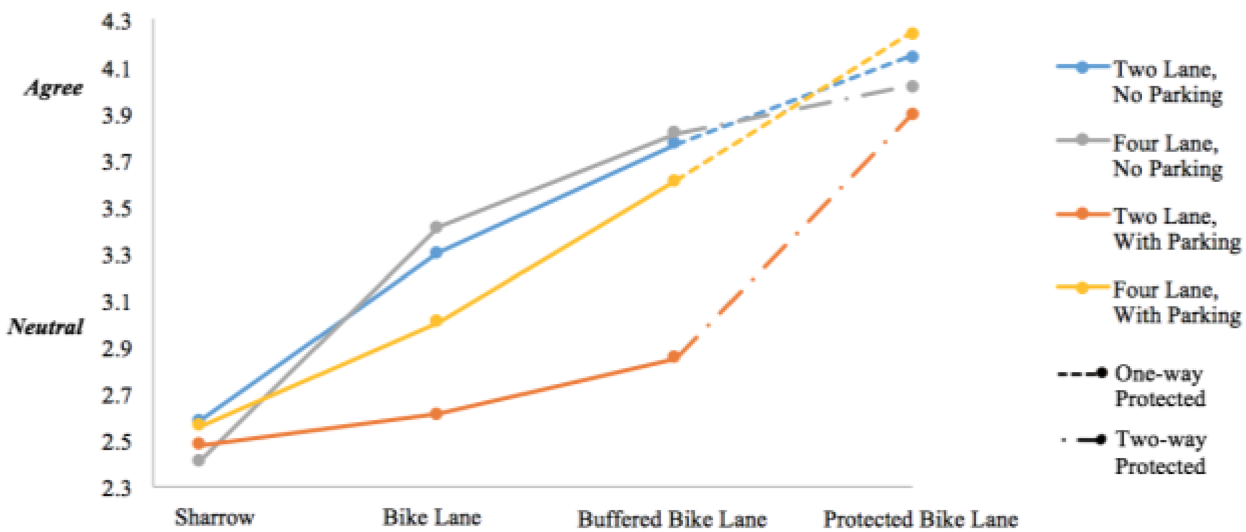


Figure 12 Average expressed safety levels for each lane configuration by bicycle infrastructure type.

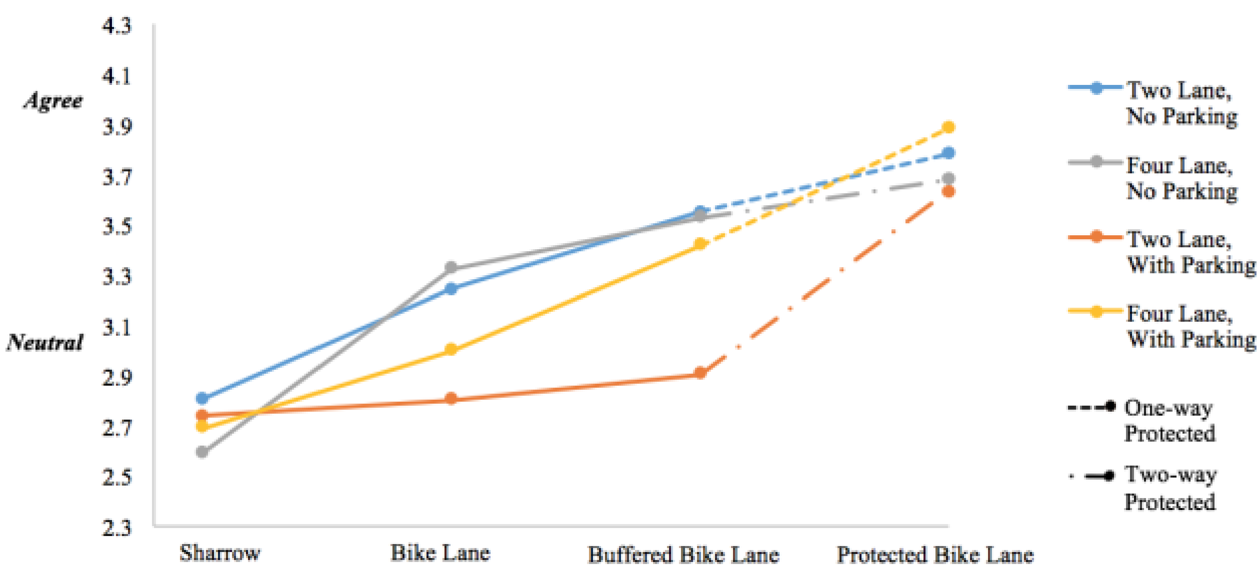


Figure 13 Average expressed level of willingness to try for each lane configuration by bicycle infrastructure type.

Ratings for the three different measures tended to follow the same patterns. This indicates that respondents did not make much distinction between the different questions for each image, which may result from a lack of experience that would allow one to rate a given infrastructure as safe but not comfortable, or vice versa, for example.

Each of the three measures improved for each increased degree of separation provided by the bicycling infrastructure, indicating a positive benefit associated with separation from moving and parked cars. Each version of the survey began the infrastructure image section with a sharrow configuration, which allows the sharrow infrastructure layouts to serve as a base measurement for each lane configuration. In each version, the sharrow configurations received the lowest ratings, and the existence of any sort of spatial separation was influential in increasing each perception measure. Average ratings for each traditional bike lane scenario were higher than those for sharrows on the same roadway configuration. The difference is more pronounced for bicycle lanes without adjacent curb parking, which supports the earlier focus group finding of the disutility of combining bike lanes with on street parking. Buffered bike lanes received higher average ratings than traditional bike lanes, and also saw the same disutility of parking lanes.

As previously mentioned, two different protected bike lane scenarios were tested in the survey. Table 58 shows the average ratings for each of the protected bike lane scenarios along with the multi-use path. As shown previously, the presence of the barrier was effective in overcoming the obstacles created by the inclusion of parking or extra traffic lanes. Focus group participants suggested that one-way protected bike lanes would be preferable to two-way, and this is also seen in the figures, although the advantage is relatively slight. It is expected that the primary determinant for preferences of protected bike lanes would be based on whether it is one-way or two-way, as opposed to the parking and traffic lane characteristics, which were more influential in shaping perceptions of the more vulnerable layouts. The multi-use path received ratings comparable to those of the one-way and two-way protected bike lanes.

Table 58 Average Ratings for Comfort, Safety, and Willingness to Try for Protected Bike Lanes and Multi-Use Paths

	One-way Protected		Two-way Protected		
	Two-Lane/ No Parking	Four-Lane with Parking	Two-Lane with Parking	Four-Lane/ No Parking	Multi-Use Path
Comfort	4.12	4.13	3.89	3.97	4.14
Safety	4.14	4.24	3.89	4.01	4.15
Willingness to Try	3.78	3.89	3.63	3.68	3.95

5.3.1 Infrastructure and Roadway Trait Models

While the descriptive analysis of the preceding subsection is useful, it is also desirable to control for a number of covariates whose effects might otherwise be confounded with those of infrastructure type and roadway configuration. Linear regression models were built using the multiple responses by 1178 respondents for each of the three dependent variables (comfort, safety, and willingness to try), as presented in Table 59. Dummy variables for each infrastructure type, along with the presence of on-street parking and additional lanes of traffic, were included in the models. Although linear regression models have limitations for application to Likert-type data, they can serve as a reliable approximation with four or more ordinal response levels with “little worry” (Bentler et al.

1987). More complex model types, which have their own advantages and disadvantages, will continue to be explored in further work; some initial results are reported in Section 5.3.2.

An issue resulting from the survey design was the emergence of a framing effect. Each version of the survey had a logical sequence of four images based on a common lane configuration, along with two out-of-sequence images. Each out-of-sequence image, which was a repeat of an image displayed in another version of the survey, appeared either before or after the most conceptually similar image of the sequence. Five roadway images were repeated in another version (bike lane with two auto lanes and no parking, buffered bike lane with two auto lanes and no parking, buffered bike lane with four auto lanes and no parking, bike lane with two auto lanes and parking, and bike lane with four auto lanes and parking). Each of these images received different responses based on the version in which they appeared. Specifically, these images attracted different responses when they were out-of-sequence (e.g. the "two-lane/no parking bike lane" image in Version 1 of Figure 6) than when they were in-sequence (the same image in Version 2). The multi-use path appeared in three versions and had consistent scores in each version.

Dummy variables were included in the regression to capture the variation due to the framing effects introduced by the interruption of the natural sequence of each version. Most images, when compared to the preceding image, changed only one variable (bike facility type, parking, or auto lanes). Conversely, each time the sequence is broken, two variables must be changed at once, either to break the sequence or to return to the sequence. For example, the bike lane with two auto lanes and parking in version 3 (in Figure 7) breaks the sequence, changing the number of auto lanes (from four to two) and the bike facility type (from sharrow to bike lane) from the previous image; however, the (out-of-sequence) bike lane with four auto lanes and parking in version 4 only changes one variable from the preceding image (the addition of parking), while the subsequent image changes two variables at once, the change of bike lane to buffered bike lane and the removal of parking. Three dummy variables were created and applied to the appropriate images when their appearance involved changing two variables at once: Bike Lane (BL)-No Parking, Buffered Bike Lane (BBL)-No Parking, and BL-Two Lanes. The BL-No Parking variable was set to 1 for the second image in version 1, which added a bike lane and removed parking compared to the preceding image; the BBL-No Parking variable was set to 1 for the two-lane buffered bike lane image in Version 1 along with the four-lane buffered bike lane in Version 4, both of which added a buffer to the bike lane and removed parking compared to the preceding image; and the BL-Two Lanes variable was set to 1 for the second image in Version 3, which introduced a bike lane and removed the additional lanes of traffic compared to the preceding image. A fourth dummy variable was also considered for the two-lane one-way protected bike lane without parking image in Version 2, however this variable was eventually excluded because it undermined the stability of the model, perhaps due to empirical collinearity issues related to the infrequent appearance of one-way protected bike lanes. The results of the linear regression for each dependent variable are presented in Table 59.

Table 59 Linear Regression for Expressed Comfort, Safety, and Willingness to Try by Infrastructure Characteristics

Variable	Comfort			Safety			Willingness to Try		
			P			P			P
Constant	2.90	***	<0.001	2.62	***	<0.001	2.82	***	<0.001
Bicycle Infrastructure Types									
Bike Lane (BL)	0.37	***	<0.001	0.45	***	<0.001	0.30	***	<0.001
Buffered BL (BBL)	0.73	***	<0.001	0.89	***	<0.001	0.57	***	<0.001
One-way Protected	1.34	***	<0.001	1.68	***	<0.001	1.12	***	<0.001
Two-way Protected	1.16	***	<0.001	1.45	***	<0.001	0.96	***	<0.001
Multi-use	1.24	***	<0.001	1.53	***	<0.001	1.12	***	<0.001
Roadway Characteristics									
Parking	-0.27	***	<0.001	-0.26	***	<0.001	-0.17	***	<0.001
Four Lanes	0.02		0.477	0.05		0.103	-0.02		0.500
Framing Effects									
BL-No Parking	0.42	***	<0.001	0.50	***	<0.001	0.41	***	<0.001
BBL-No Parking	0.22	***	<0.001	0.33	***	<0.001	0.22	**	0.002
BL-Two Lanes	0.28	***	<0.001	0.35	***	<0.001	0.22	*	0.015
# of Responses		6743			6723			6664	
R^2		0.175			0.232			0.093	

*Significant at P = 0.050 or better

**Significant at P = 0.010 or better

***Significant at P < 0.001

The dummy variables for each infrastructure type were significant. The coefficients for each of the on-street infrastructure variables were also significantly different from each other, supporting the earlier finding that greater separation of cyclists from cars increases all three measures of effectiveness. The multi-use dummy coefficient was not substantially different from the protected bike lane coefficients, however it was still included separately in the model because the multi-use images excluded the effects of roadway characteristic variables.

The framing effect terms were significant in each model. These variables show sensitivity to the comparative removal of a perceived negative aspect (parking, or additional travel lane) that is not explained by the variables indicating the absence of that aspect alone. For example, when an image without parking was presented after an image with parking, it tended to receive a higher rating than if it were preceded by an image that also had no parking.

While the framing variables picked up the influence of multiple simultaneous changes from image to image, the “Parking” and “Four Lanes” variables represented the overall effects of roadway characteristics. The parking variable was significant in all models, indicating that the overall effect of parking was still significant, even after accounting for the strong impact of the removal of parking in the few images affected by framing. The variable for the number of traffic lanes alone was not significant, though the significance of the framing variables indicates at least a situational effect when the number of lanes presented in the figure changes.

5.3.2 Alternatives to Regression

Common practice in early model development is to start with a simple linear regression model and gradually increase the complexity. Although the dependent variables of perceived safety, comfort and willingness to try are ordinal Likert-type variables, linear regression is found to be reasonably robust for 5 levels of ordinal values.

An ordered logistic regression model was also estimated for the same variables and is presented in Table 60. This type of model relaxes the assumption of linear regression that a conceptual difference of one unit in the dependent variable (i.e., the difference between a 3 and a 4) is similar to the same mathematical difference between two different options (i.e., the difference between 2 and 3). The model is otherwise conceptually similar to the linear regression model. All variables maintain their general significance level between the two models, and the coefficients have the same comparative relationship to each other.

Table 60 Ordered Logistic Regression for Expressed Comfort, Safety, and Willingness to Try by Infrastructure Characteristics

Variable	Comfort			Safety			Willingness to Try		
	Coefficient		P	Coefficient		P	Coefficient		P
Intercept 1/2	-1.82	***	<0.001	-1.37	***	<0.001	-1.08	***	<0.001
Intercept 2/3	-0.54	***	<0.001	-0.01		0.844	-0.32	***	<0.001
Intercept 3/4	0.71	***	<0.001	1.12	***	<0.001	0.51	***	<0.001
Intercept 4/5	2.49	***	<0.001	2.94	***	<0.001	1.93	***	<0.001
Bicycle Infrastructure Types									
Bike Lane (BL)	0.59	***	<0.001	0.72	***	<0.001	0.38	***	<0.001
Buffered BL (BB)	1.18	***	<0.001	1.41	***	<0.001	0.74	***	<0.001
One-way Protected	2.29	***	<0.001	2.82	***	<0.001	1.56	***	<0.001
Two-way Protected	2.01	***	<0.001	2.44	***	<0.001	1.30	***	<0.001
Multi-use	2.21	***	<0.001	2.63	***	<0.001	1.61	***	<0.001
Roadway Characteristics									
Parking	-0.43	***	<0.001	-0.40	***	<0.001	-0.23	***	<0.001
Four Lanes	0.03		0.554	0.09		0.071	-0.04		0.412
Framing Effects									
BL-No Parking	0.67	***	<0.001	0.75	***	<0.001	0.55	***	<0.001
BBL-No Parking	0.36	***	<0.001	0.54	***	<0.001	0.30	**	0.002
BL-Two Lanes	0.45	***	<0.001	0.56	***	<0.001	0.28	*	0.019
# of Responses	6743			6723			6664		

*Significant at P = 0.050 or better

**Significant at P = 0.010 or better

***Significant at P < 0.001

Although ordered logistic regression does not require categories to differ by the same amount, it does require the slopes (i.e. the coefficients of explanatory variables) to be the same across categories. This is called the parallel lines assumption, and is likewise tested using the Brant Parallel Lines Test. This test was run on the three ordered logistic models, and the results are presented in Table 61. A low P value in this test for either the combined model or for a particular variable indicates violation of the parallel lines assumption. Low P values indicate that bicycle infrastructure variables violate this assumption, indicating that a generalized ordered logit or multinomial logit model may be a better fit than the ordered logit. The investigation of these models is a direction for further work.

Table 61 Brant Parallel Line Test Results for Ordered Logistic Regression models for Comfort, Safety, and Willingness to Try

Variable	Comfort			Safety			Willingness to Try		
	χ^2	df	P	χ^2	df	P	χ^2	df	P
Combined Model	95.6	30	<0.01	108.9	30	<0.01	99.7	30	<0.01
Bicycle Infrastructure Types									
Bike Lane (BL)	8.6	3	0.04	12.3	3	0.01	10.6	3	0.01
Buffered BL (BB)	12.6	3	0.01	14.6	3	<0.01	7.2	3	0.06
One-way Protected	8.8	3	0.03	5.2	3	0.16	7.1	3	0.07
Two-way Protected	17.6	3	<0.01	41.0	3	<0.01	22.9	3	<0.01
Multi-use	15.7	3	<0.01	23.7	3	<0.01	7.8	3	0.05
Roadway Characteristics									
Parking	15.4	3	<0.01	11.5	3	0.01	6.6	3	0.09
Four Lanes	1.0	3	0.80	1.4	3	0.70	17.3	3	<0.01
Framing Effects									
BL-No Parking	1.8	3	0.62	2.3	3	0.52	5.8	3	0.12
BBL-No Parking	2.1	3	0.55	2.4	3	0.50	0.0	3	0.99
BL-Two Lanes	2.8	3	0.43	4.6	3	0.20	2.8	3	0.43

5.3.3 Additional Influence of Sociodemographic Traits

The influence of sociodemographic covariates is additionally informative in its own right. The previous models were supplemented with sociodemographic data, as presented in Table 62. For the few cases where this information was not reported, data obtained from targeted marketing data sources was used as an estimate. In all three models, education and age were significant, with consistent signs between models. However, both coefficients were comparatively larger in the willingness to try model. Older individuals tended to express lower perceived comfort and safety, and even more so for willingness to try. Individuals with higher levels of education tended to express greater perceived comfort and safety, and even more so for willingness to try.

The number of vehicles per licensed driver (at the household level, capped at 1.0) was significant in the comfort and willingness to try models. This variable measures individuals' access to an automobile in their home, and indicates that those with increased access tend to view a given infrastructure as less comfortable and as something they would be less willing to try.

The coefficients for driver's license and child in home were significant only in the safety model. The positive coefficient for driver's license may indicate that those with a license feel more control over the safety of the roadway in general. The child in home coefficient was negative, which indicates that those who have a child in their home tend to view bicycling infrastructure as less safe than those who do not. This could be the result of considering cycling with their children or of an increased attention to safety due to the responsibilities of raising children.

Coefficients on the female and African-American variables were significant only in the willingness to try model. This indicates that these two subsets of the population may be less willing than others to try a given infrastructure configuration, even if their

Table 62 Linear Regression for Expressed Comfort, Safety, and Willingness to Try by Infrastructure and Individual Characteristics

Variable	Comfort			Safety			Willingness to Try		
	Coefficient		P	Coefficient		P	Coefficient		P
Constant	3.09	***	<0.001	2.55	***	<0.001	3.59	***	<0.001
Bicycle Infrastructure Types									
Bike Lane	0.40	***	<0.001	0.47	***	<0.001	0.32	***	<0.001
Buffered Bike Lane	0.77	***	<0.001	0.90	***	<0.001	0.59	***	<0.001
One-way Protected	1.39	***	<0.001	1.69	***	<0.001	1.15	***	<0.001
Two-way Protected	1.21	***	<0.001	1.47	***	<0.001	1.03	***	<0.001
Multi-use	1.30	***	<0.001	1.55	***	<0.001	1.19	***	<0.001
Roadway Characteristics									
Parking	-0.27	***	<0.001	-0.25	***	<0.001	-0.16	***	<0.001
Four Lanes	0.03		0.477	0.04		0.103	-0.03		0.441
Framing Effects									
BL-No Parking	0.41	***	<0.001	0.50	***	<0.001	0.44	***	<0.001
BBL-No Parking	0.23	***	<0.001	0.34	***	<0.001	0.26	***	<0.001
BL-Two Lanes	0.26	***	<0.001	0.31	***	<0.001	0.19	*	0.038
Sociodemographics									
Age	-0.004	***	<0.001	-0.004	***	<0.001	-0.01	***	<0.001
Education	0.04	***	<0.001	0.03	**	0.001	0.09	***	<0.001
Vehicles Per Driver	-0.16	**	0.003				-0.38	***	<0.001
Driver's License				0.18	***	<0.001			
Child in Home				-0.08	*	0.033			
Female							-0.29	***	<0.001
African-American							-0.08	*	0.047
# of Responses	6159			6529			6086		
R^2	0.201			0.248			0.153		

*Significant at P = 0.050 or better

**Significant at P = 0.010 or better

***Significant at P < 0.001

perceptions of its safety and comfort are similar to those of others. This could be due to important factors other than safety and comfort and may serve as the basis for further analysis.

Sociodemographic characteristics seemed to play a larger role in the willingness to try model than for the other two perceptions, as seen by the 0.060 increase in the R^2 value from 0.093 (Table 59) to 0.153 (compared to increases of 0.026 and 0.016, respectively, for the other two models). This indicates that individual characteristics are more influential on potential users' decisions of whether to use a certain type of infrastructure than on their perceptions of whether it is safe or comfortable in general.

5.3.4 Segmented Models: Ridership Status

A segmented model was developed to investigate how the influence of the other explanatory variables differs by rider group. The sample was segmented using the previous criteria for rider statuses of potential rider, recreational, utilitarian, and those that cannot bike.

5. Potential cyclist (N=700)—those who report zero miles of cycling per month, but report being able to ride a bike, regardless of confidence level.
6. Recreational cyclist (N=166)—those who bike a non-zero distance per month, but bike less than once a month *and* less than a mile a week, on average, for utilitarian purposes.
7. Utilitarian cyclist (N=84)—those who bike at least once a month *or* at least a mile a week, on average, for utilitarian purposes.
8. Cannot bike (N=163)—those who state that they cannot ride a bicycle.

The potential cyclist population was used as the base, and incremental-difference coefficients are reported for segments with significant differences from the base group. Not all segments were significantly different from the base in each model.

Each segmented model started from the previously reported OLS models for comfort, safety, and willingness to try, respectively. Dummy variables were introduced for the “recreation”, “utilitarian”, and “cannot bike” segments, using the “potential cyclists” as the base. The incremental effects for each segment were estimated using interaction terms between the main effect explanatory variables and the segment dummy variables, piece-wise removing insignificant variables (constraining them to be 0). Insignificant variables were included in cases with borderline significance, where a main effect was insignificant but an associated interaction effect was significant, and/or in cases where the coefficient is necessary for interpretation of a similar variable, such as for different types of bicycle infrastructure.

A segmented model for expressed comfort is presented in Table 63. The primary differences uncovered by this model are the incremental effects for utilitarian cyclists. Compared to the rest of the population, utilitarian cyclists were less likely to express discomfort due to the presence of parking. Age is a net-positive coefficient for the utilitarian group, implying that older utilitarian cyclists are more likely to rate infrastructure as comfortable.

A segmented model for expressed safety is presented in Table 64. Like the previous model, most of the differences come from the utilitarian group. Each infrastructure variable is positive for utilitarian cyclists, indicating that although all groups see each added degree of protection as an increase in safety, the group that cycles most perceives an even greater increase in safety. The parking coefficient was positive for utilitarian cyclists, with a similar magnitude to the (negative) base parking coefficient, indicating that utilitarian cyclists do not view on-street parking as significantly unsafe like the rest of the sample does. The coefficients for the variable measuring the presence of children in the home for the utilitarian and unable groups were significantly (or borderline significantly) negative, while the base coefficient became insignificant in this model, indicating that the negative impact on perceived safety associated with the presence of a child in the home is driven by these two groups.

A segmented model for expressed willingness to try is presented in Table 65. Notably the only roadway characteristics to be significant in any segmentation were the parking and four lanes variables for those unable to bike. Both were positive, with higher magnitudes than the negative base coefficients. This segregation likewise allows the coefficient for the rest of the population to be more negative for the parking variable, while the four-lane variable inches closer to significantly negative. This implies that the stated preferences of those who can’t bike may contradict those of the rest of the population in terms of willingness to try cycling in the presence of parking and additional traffic lanes. Although the change in sign for these coefficients may seem unexpected, the rather large magnitude of the negative constant term for that group indicates that this group is still substantially less willing to try cycling in comparison to the other groups. The coefficients for age are all significant and have similar magnitudes, with only the base being negative. This indicates that age is a deterrent for those in the potential cyclist group, but does not have a significant effect among the recreation, utilitarian, and unable groups.

Table 63 Linear Regression for Expressed Comfort by Infrastructure and Individual Characteristics, Segmented by Rider Type (6038 Responses, R^2=0.212, Adj R^2=0.210)

				Incremental Effects								
Variable	Main Effects	P		Recreation	P		Utilitarian	P		Unable	P	
Constant	3.14	<0.001	***	0.17	<0.001	***	-0.54	0.012	*	-0.09	0.031	*
Bicycle Infrastructure Types												
Bike Lane	0.40	<0.001	***									
Buffered Bike Lane	0.76	<0.001	***									
One-way Protected	1.39	<0.001	***									
Two-way Protected	1.22	<0.001	***									
Multi-use	1.30	<0.001	***									
Roadway Characteristics												
Parking	-0.29	<0.001	***				0.20	0.046	*			
Four Lanes	0.02	0.438										
Framing Effects												
BL-No Parking	0.41	<0.001	***									
BB-No Parking	0.24	<0.001	***									
BL- Two Lanes	0.24	0.001	**									
Sociodemographics												
Age	-0.003	<0.001	***				0.009	0.008	**			
Education	0.03	0.002	**									
Vehicles per Driver	-0.23	<0.001	***				0.44	0.010	**			

Table 64 Linear Regression for Expressed Safety by Infrastructure and Individual Characteristics, Segmented by Rider Type (5982 Responses, R^2=0.268, Adj R^2=0.265)

				Incremental Effects								
Variable	Main Effects	P		Recreation	P		Utilitarian	P		Unable	P	
Constant	2.64	<0.001	***	0.15	<0.001	***	-0.86	<0.001	***	-0.01	0.858	
Bicycle Infrastructure Types												
Bike Lane (BL)	0.47	<0.001	***				0.31	0.041	*			
Buffered BL (BB)	0.90	<0.001	***				0.36	0.026	*			
One-way Protected	1.72	<0.001	***				0.44	0.030	*			
Two-way Protected	1.50	<0.001	***				0.40	0.072				
Multi-use	1.56	<0.001	***				0.59	0.002	**			
Roadway Characteristics												
Parking	-0.28	<0.001	***				0.29	0.009	**			
Four Lanes	0.05	0.099										
Framing Effects												
BL-No Parking	0.51	<0.001	***									
BB-No Parking	0.36	<0.001	***									
BL- Two Lanes	0.29	<0.001	***									
Sociodemographics												
Age	-0.004	<0.001	***				0.006	0.095				
Child in Home	-0.05	0.236					-0.27	0.036	*	-0.25	0.082	
Driver’s License	0.22	0.015	*									
Education	0.02	0.032	*									
Vehicles per Driver	-0.17	0.007	**				0.44	0.014	*			

Table 65 Linear Regression for Expressed Willingness to Try by Infrastructure and Individual Characteristics, Segmented by Rider Type (5966 Responses, R^2=0.206, Adj R^2=0.203)

Variable	Main Effects	P		Incremental Effects Recreation	P		Utilitarian	P		Unable	P	
Constant	3.74	<0.001	***	-0.65	0.004	**	-0.20	0.428		-1.89	<0.001	***
Bicycle Infrastructure Types												
Bike Lane (BL)	0.32	<0.001	***									
Buffered BL (BB)	0.59	<0.001	***									
One-way Protected	1.15	<0.001	***									
Two-way Protected	1.02	<0.001	***									
Multi-use	1.19	<0.001	***									
Roadway Characteristics												
Parking	-0.21	<0.001	***							0.37	<0.001	***
Four Lanes	-0.05	0.152								0.24	0.014	*
Framing Effects												
BL-No Parking	0.44	<0.001	***									
BB-No Parking	0.25	<0.001	***									
BL- Two Lanes	0.18	0.043	*									
Sociodemographics												
Age	-0.009	<0.001	***	0.008	0.009	**	0.009	0.032	*	0.009	0.015	*
Female	-0.19	<0.001	***									
African American	-0.16	<0.001	***							0.62	<0.001	***
Education	0.03	0.012	*	0.15	<0.001	***						
Vehicles per Driver	-0.48	<0.001	***				0.50	0.016	*	0.40	0.026	*

5.4 Summary

The first-wave survey confirmed that the factors influencing perceived safety and comfort are strongly related to those impacting a user's willingness to bike. Respondents rated infrastructure with a higher degree of separation from drivers more positively, with protected bike lanes and multi-use paths being the best (though no major differences were observed between protected bike lanes and multi-use paths). Parking was a clear deterrent for all measures of preference, while the number of automobile lanes was significant only as a framing effect. Protected bike lanes seemed effective in reducing the negative effects of parking and traffic lanes.

User characteristics were significant in modelling comfort, safety, and willingness to try. Sociodemographic information was more influential in predicting willingness to try, indicating that willingness to try may depend more on the characteristics of the individual than do perceived comfort and safety.

In the next phase of the project, the research team will focus on investigating the contribution of attitudinal variables to the three dependent variables (comfort, safety, and willingness to try). Other model structures will be further explored, including segmented models that will seek to explain variation in perceptions based on cycling experience and other characteristics. Further, we will analyze changes in individuals' behaviors and willingness to try associated with the opening of new infrastructure at the three treatment sites (through the analysis of the "before and after" survey data). It is anticipated that this analysis will provide meaningful estimates for factors influencing perceived safety and barriers to cycling for potential cyclists as well as for the greater population.

CHAPTER 6. CONCLUSIONS

Although cycling for transportation has been experiencing a resurgence in much of the U.S., research on user preferences for cycling has been limited largely to major cycling-friendly cities. This thesis discusses research conducted in communities in Alabama and Tennessee, where cycling is less visible. Three of communities in the process of implementing new bicycle transportation facilities were identified as *treatment sites*, while three more communities, where no such plans were on the immediate horizon, were identified as *control sites*, which were paired up with a treatment site with similar land use and demographic characteristics. The methodology of the study includes focus groups, which were conducted to gauge responses about challenges specific to cycling in these communities, and a mailed/online survey (N=1223, response rate=5.1%) that was deployed in Chattanooga, TN, and Birmingham, Anniston, Talladega, Opelika, and Northport, AL.

6.1 Focus Groups

The findings from the focus groups held in Chattanooga, Anniston, and Opelika provide qualitative information about what concerns current and potential cyclists about cycling. Our focus groups revealed that perceived safety from moving vehicle collisions and adjacent parked cars was a major factor in potential cyclists' willingness to use infrastructure, with substantial concern about unsafe driver behavior. Participants were attracted to infrastructure with a higher degree of separation from drivers, as they felt they would be safer from inattentive and aggressive drivers, both in the travel lane and the parking lane. Hazards from dooring and cars parking were among the highest concerns, followed closely by hazards from cars turning into or overtaking bicycles. Buffered bicycle lanes and protected bicycle lanes with a physical barrier such as bollards or planters were all viewed as substantially improving comfort, but even basic bike lanes were reassuring provided they were not adjacent to car parking. When curbside car parking was introduced, perceived comfort levels plummeted, and only recovered with buffering to place the bike lane outside the door zone or physical separation from parked cars and the door zone. Eliminating curbside parking next to bike lanes, as is common in Europe, appears to increase comfort along with more complex and expensive buffering or protected bicycle lanes.

In addition to these qualitative results, the focus groups also proved useful in informing the design of the quantitative research efforts such as the survey that was later implemented in this study. The focus group results are important as they can help lead the discussion of cyclist needs and preferences when it comes to cycling infrastructure design.

6.2 Survey Description

A 12-page survey was mailed to residents in each of the six study areas, with 1,223 respondents and 1,188 usable responses. It was intentionally designed to appear as a broad transportation survey, so as to not bias response rates towards those more inclined to bike. As such, the survey results provided a rich dataset with data from six different sections:

A. Attitudes
B. Technology usage
C. Household location

D. Daily travel

E. Bicycling experience

F. Demographics

The primary section of interest was the bicycling experience section. Respondents provided information about their own bicycling behavior, which allowed for segmenting respondents into four different cyclist categories: potential cyclist (700), recreational/occasional cyclist (166), utilitarian cyclist (84), and those who are unable to cycle (163). Respondents also provided input on their preferences for bike infrastructure, including the effects of parking, number of lanes, and bike facility type. These response data allowed for exploration of the differences in preferences between the groups and the introduction of hypotheses to test more rigorously with models.

6.3 User Preference Analysis

The survey analysis confirmed similarities between expressed feelings of being safe, comfortable, and willing to try biking on different roadway cross-sections. Respondents rated infrastructure with a higher degree of separation from drivers more positively, with protected bike lanes and multi-use paths being the best. Parking was a clear deterrent for all measures of preference, while the number of automobile lanes was not clear. Protected bike lanes seemed effective in reducing the negative effects of parking.

User characteristics were significant in modelling comfort, safety, and willingness to try. Sociodemographic information was more influential in predicting willingness to try, indicating that even when safety and comfort are similarly perceived across population segments, willingness to try can differ.

6.4 Further Work

Although the work presented in this thesis produces strong evidence in and of itself, further analysis is still being done on the same data. Future models will investigate the contribution of attitudinal variables to the three dependent variables (comfort, safety, and willingness to try). Other model structures will be further explored, including multinomial logit models that may be better suited to Likert-type ordered variables. Further, the deployment of the second-wave survey in Spring 2018 will allow an analysis of changes in individuals' behaviors and preferences associated with the opening of new infrastructure at the three treatment sites (through the analysis of the "before and after" survey data). It is anticipated that this analysis will provide meaningful results for potential cyclists as well as for the greater population.

Although this thesis only presents research pertaining to the six study sites indicated, the survey has also been administered to four communities in Atlanta, two of which have planned extensions of the BeltLine, a major multiuse path intended to circle the city. Data from these neighborhoods will be compared with the initial data from the NCHRP-funded study, and ultimately combined for expanded analysis.

APPENDIX A. SURVEY INSTRUMENT

Community Transportation Study

Dear <Resident>,

Several weeks ago, we contacted you about a Georgia Tech study on transportation in your community. This is a follow-up invitation to complete this survey, and an additional one next year, as part of that study. Your participation is voluntary, but every response is vital. We are interested in your answer to **each** question, even those on topics that might be less familiar. The survey will take about 30 minutes. If you have any questions, feel free to contact us at survey<VersionNumber>@ce.gatech.edu, or call toll-free *1-855-444-2930*.

We ask that the survey be filled out by the adult (19 years old or older) in your household whose birthday is the soonest from now. If that person is unwilling, another adult in the household is welcome to do so. Your identity will never be publicly disclosed. After completing each survey, we'll send you a coupon for a free treat as a token of our gratitude. You won't receive any other personal benefits for participating, aside from contributing to better transportation planning.

To make sure we count your opinions in the study, please complete the survey by **October 28, 2016** and send it back to us in the postage-paid envelope provided. If you are unable to fill out the survey by then, we would still welcome it as soon as you can. Thanks again!

Sincerely, Professor Kari Watkins

Kari E. Watkins

Part A: Your Views on Various Topics

To begin, we'd like to learn more about your opinions on various issues related to travel and lifestyles. This will help us understand your answers to later questions. We want your true opinion on each statement, or your best guess for topics you are not very familiar with. Remember, **there are no "right" or "wrong" answers!**

1. For each of the following statements, please choose the response that most closely fits your reaction.

	Strongly disagree	*Disagree*	*Neutral or No opinion*	*Agree*	*Strongly agree*
I like the idea of living in a neighborhood where I can walk to the grocery store.	☐	☐	☐	☐	☐
The importance of exercise is overrated.	☐	☐	☐	☐	☐
Owning a car is an important sign of my freedom.	☐	☐	☐	☐	☐
Most drivers don't seem to notice bicyclists.	☐	☐	☐	☐	☐
Taking risks fits my personality.	☐	☐	☐	☐	☐
I'm often in a hurry to be somewhere else.	☐	☐	☐	☐	☐
This country has gone too far in its efforts to protect the environment.	☐	☐	☐	☐	☐
I generally enjoy the act of traveling itself.	☐	☐	☐	☐	☐
Around here, adults who bicycle for transportation are viewed as odd.	☐	☐	☐	☐	☐
The functionality of a car is more important to me than its brand.	☐	☐	☐	☐	☐
I can usually find good ways to use the time I spend traveling each day.	☐	☐	☐	☐	☐
I like to be among the first people to have the latest technology.	☐	☐	☐	☐	☐
I am trying to have an environmentally-friendly lifestyle.	☐	☐	☐	☐	☐

	Strongly disagree	*Disagree*	*Neutral or No opinion*	*Agree*	*Strongly agree*
Most bicyclists look like they spend a lot of money on their bikes.					
I like trying things that are new and different.					
I am usually very cautious with strangers.					
I like traveling by car.					
It's pretty hard for my friends to get me to change my mind.					
Kids often ride bicycles around my neigh-borhood for fun.					
My time spent in everyday travel is generally wasted time.					
I'm too busy to do many things I'd like to do.					
I like the idea of sometimes walking or biking instead of taking the car.					
I feel like I need to make the most of every single minute.					
Many bicyclists appear to have little regard for their personal safety.					
I am fine with not owning a car, as long as I can use/rent one any time I need it.					
Improving sidewalks should be a priority for my town.					
The only good thing about traveling is arriving at your destination.					
Most bicyclists look like they are too poor to own a car.					
I like using public transit when it provides good service.					
Getting regular exercise is very important to me.					
My dream is to live in a large house with a big yard.					
I would bicycle more if my friends / family came with me.					
I avoid doing things that I know my friends would dislike.					
I prefer to minimize the material goods I possess.					
Our first concern for transportation should be helping cars get around better.					
My phone is so important to me, it’s almost a part of my body.					
I like bicycling.					
I am generally satisfied with my life.					

Part B: Technology in Your Life

In this short section, we are interested in learning about your online preferences and habits, and understanding how they relate to your lifestyles and travel choices.

1. Do you **regularly use** any of the following devices (for work or personal purposes)? Please respond to each.

	Yes	*No*
Smartphone	☐	☐
Basic (non-smartphone) cell phone	☐	☐
Laptop	☐	☐
Desktop computer	☐	☐
Tablet (e.g., iPad, Galaxy Tab)	☐	☐
Wearable technology (e.g., Apple Watch, Fitbit)	☐	☐

2. How often do you use a **computer** or **smartphone app** to do each of the following things?

	Seldom or never	*Several times a year*	*At least once a month*	*At least once a week*	*(Almost) every day*
Check traffic to plan my route or departure time	☐	☐	☐	☐	☐
Check bus / train arrivals	☐	☐	☐	☐	☐
Decide which means of transportation to use for a trip	☐	☐	☐	☐	☐
Identify possible destinations (e.g., restaurant, store)	☐	☐	☐	☐	☐
Learn how to get to a new place	☐	☐	☐	☐	☐
Navigate in real time (e.g., using Garmin, Waze)	☐	☐	☐	☐	☐
Check the weather	☐	☐	☐	☐	☐

Part C: The Place You Call Home

Learning more about your home will help us understand how these factors affect the way you organize your daily activities and the way you travel.

1. What best describes the type of residence you currently live in? Please check one.

☐ Detached (free-standing) home
☐ Attached home / duplex / townhouse
☐ Apartment /condo building
☐ Dormitory
☐ Other (please specify): ____________

2. In what year (YYYY) did you move to your current address?

Year: ________

☐ I have lived here my entire life

3. Knowing more about your general neighborhood will help us put your transportation choices and opinions in context. Please give your address or, if you prefer, an intersection (two streets that cross) near your home.

   ______________________________ (and ______________________________)

   City: ______________________________ Zip code: ______________________________

4. Who lives with you? Please check all that apply:

   - ☐ My partner / husband / wife
   - ☐ My child(ren) or grandchild(ren)
   - ☐ My parent(s) or grandparent(s)
   - ☐ One or more of my siblings
   - ☐ Some other relative(s)
   - ☐ One or more roommates / housemates
   - ☐ I live alone
   - ☐ Other (please specify): ______________

Part D: Your Daily Travel

Please think about your everyday travel: where you go to work or school, shop, and relax. We're interested in learning about your typical transportation choices.

1. On average, how many days per week do you do each of the following? By **telecommuting**, we mean **working / studying** from home or a nearby location (not counting overtime work at home).

   Travel to **work:** ____ days/wk ☐ Not applicable

   Travel to **school:**____ days/wk ☐ Not applicable

   Telecommute: ____ days/wk ☐ Not applicable

For the following block of questions, please consider the regular trip to your main **work / school** location. If you travel to **more than one location** on a regular basis, consider the location to which you travel most often.

→ If you don't travel to **work or school**, please go to **question 7 of Part D, page 5**

2. How far do you live from your main **work / school** destination? _______ miles

3. How long does it usually take you to get from home to **work / school** (one-way trip)? _____ minutes

4. Knowing more about where you **work / study** will help us better understand the transportation options that are available to you. Please give the address or, if you prefer, an intersection (two streets that cross) that is close to your **main work / school location**.

   ______________________________ (and ______________________________)

   City: ______________________________ Zip code: ______________________________

5. In terms of its **value to you**, how would you rate the time you typically spend on your **work / school** trip? Place a mark (×) at the most appropriate place on the scale below:

   Mostly wasted time |——————|——————|——————|——————|——————| *Mostly useful time*

6. Considering your **trips to work / school**, please indicate **how often** you use each of the following means of transportation for such trips:

	Never	*Less than once a **month***	*1-3 days a **month***	*1-2 days a **week***	*3-4 days a **week***	*5 or more days a **week***
Alone in personal car, truck, van, or motorcycle	☐	☐	☐	☐	☐	☐
With others in car, van...	☐	☐	☐	☐	☐	☐
Public transit	☐	☐	☐	☐	☐	☐
Taxi	☐	☐	☐	☐	☐	☐
Uber, Lyft, etc.	☐	☐	☐	☐	☐	☐
Bicycle	☐	☐	☐	☐	☐	☐
Walk	☐	☐	☐	☐	☐	☐
Other: ___________	☐	☐	☐	☐	☐	☐

7. Consider your **trips for other** (non-work / school) **purposes** (e.g., for grocery or clothes shopping, going to a restaurant/bar or ball game, attending church, visiting others, running errands, or for hobbies). Please indicate **how often** you typically make such trips, using each of the following means of transportation:

	Never	*Less than once a **month***	*1-3 days a **month***	*1-2 days a **week***	*3-4 days a **week***	*5 or more days a **week***
Alone in personal car, truck, van, or motorcycle	☐	☐	☐	☐	☐	☐
With others in car, van...	☐	☐	☐	☐	☐	☐
Public transit	☐	☐	☐	☐	☐	☐
Taxi	☐	☐	☐	☐	☐	☐
Uber, Lyft, etc.	☐	☐	☐	☐	☐	☐
Bicycle	☐	☐	☐	☐	☐	☐
Walk	☐	☐	☐	☐	☐	☐
Other: ____________	☐	☐	☐	☐	☐	☐

8. Thinking about all your travel, would you **like** to travel **more** or **less** by the following **means of transportation,** and for the following **purposes**? Please respond for **each means** and **each purpose**.

I'd like to travel:	*Less*	*About the same*	*More*
By car/truck/van /motorcycle	☐	☐	☐
By public transit	☐	☐	☐
By bicycle	☐	☐	☐
By walking	☐	☐	☐
By other: _______	☐	☐	☐

I'd like to travel:	*Less*	*About the same*	*More*
For work / school	☐	☐	☐
For shopping	☐	☐	☐
For social	☐	☐	☐
For entertainment	☐	☐	☐
For eating out	☐	☐	☐
For other:______	☐	☐	☐

With respect to **how well they meet your current needs**, please rate the four most common means of travel on each of the following attributes. We are interested in your views on **each,** even **if you seldom** or **never use** some of these means.

Personal vehicle (e.g., car, truck, van, motorcycle)	*Very bad*	*Bad*	*Neutral or No opinion*	*Good*	*Very good*
Overall rating as a means of travel for me	☐	☐	☐	☐	☐
Comfort	☐	☐	☐	☐	☐
Ability to get where I need or want to go	☐	☐	☐	☐	☐
Reliability	☐	☐	☐	☐	☐
Safety / security	☐	☐	☐	☐	☐
Effect on the environment	☐	☐	☐	☐	☐
Cost	☐	☐	☐	☐	☐
Availability when needed / wanted	☐	☐	☐	☐	☐
Traveling in poor weather conditions	☐	☐	☐	☐	☐
Ability to stop at additional places on the same trip	☐	☐	☐	☐	☐
Avoiding congestion	☐	☐	☐	☐	☐
Privacy	☐	☐	☐	☐	☐
Ability to carry things with me	☐	☐	☐	☐	☐
Ability to spend travel time in useful ways	☐	☐	☐	☐	☐
Ability to relax / have fun while traveling	☐	☐	☐	☐	☐

Public transportation (e.g., local bus)	*Very bad*	*Bad*	*Neutral or No opinion*	*Good*	*Very good*
Overall rating as a means of travel for me	☐	☐	☐	☐	☐
Comfort	☐	☐	☐	☐	☐
Ability to get where I need or want to go	☐	☐	☐	☐	☐
Reliability	☐	☐	☐	☐	☐
Safety / security	☐	☐	☐	☐	☐
Effect on the environment	☐	☐	☐	☐	☐
Cost	☐	☐	☐	☐	☐
Availability when needed/ wanted	☐	☐	☐	☐	☐
Traveling in poor weather conditions	☐	☐	☐	☐	☐
Ability to stop at additional places on the same trip	☐	☐	☐	☐	☐
Avoiding congestion	☐	☐	☐	☐	☐
Privacy	☐	☐	☐	☐	☐
Ability to carry things with me	☐	☐	☐	☐	☐
Ability to spend travel time in useful ways	☐	☐	☐	☐	☐
Ability to relax / have fun while traveling	☐	☐	☐	☐	☐

Remember, we want your considered opinions on each means of travel, **even if you never use** some of them.

Bicycling	*Very bad*	*Bad*	*Neutral or No opinion*	*Good*	*Very good*
Overall rating as a means of travel for me	☐	☐	☐	☐	☐
Comfort	☐	☐	☐	☐	☐
Ability to get where I need or want to go	☐	☐	☐	☐	☐
Reliability	☐	☐	☐	☐	☐
Safety / security	☐	☐	☐	☐	☐
Effect on the environment	☐	☐	☐	☐	☐
Cost	☐	☐	☐	☐	☐
Availability when needed/ wanted	☐	☐	☐	☐	☐
Traveling in poor weather conditions	☐	☐	☐	☐	☐
Ability to stop at additional places on the same trip	☐	☐	☐	☐	☐
Avoiding congestion	☐	☐	☐	☐	☐
Privacy	☐	☐	☐	☐	☐
Ability to carry things with me	☐	☐	☐	☐	☐
Ability to spend travel time in useful ways	☐	☐	☐	☐	☐
Ability to relax / have fun while traveling	☐	☐	☐	☐	☐

Walking	*Very bad*	*Bad*	*Neutral or No opinion*	*Good*	*Very good*
Overall rating as a means of travel for me	☐	☐	☐	☐	☐
Comfort	☐	☐	☐	☐	☐
Ability to get where I need or want to go	☐	☐	☐	☐	☐
Reliability	☐	☐	☐	☐	☐
Safety / security	☐	☐	☐	☐	☐
Effect on the environment	☐	☐	☐	☐	☐
Cost	☐	☐	☐	☐	☐
Availability when needed/ wanted	☐	☐	☐	☐	☐
Traveling in poor weather conditions	☐	☐	☐	☐	☐
Ability to stop at additional places on the same trip	☐	☐	☐	☐	☐
Avoiding congestion	☐	☐	☐	☐	☐
Privacy	☐	☐	☐	☐	☐
Ability to carry things with me	☐	☐	☐	☐	☐
Ability to spend travel time in useful ways	☐	☐	☐	☐	☐
Ability to relax / have fun while traveling	☐	☐	☐	☐	☐

On the next two pages, we portray six different kinds of bikeways in use today. Please look at the images carefully and answer a few questions for each one.

<VERSION 1>

Sharrows on 2-lane road

Sharrows ("share arrows") show that motorists and bicyclists will be sharing the road. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Bike lane on 2-lane road

A bike lane is a dedicated lane for bicycling, separated with pavement markings only. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Buffered bike lane on 2-lane road

A buffered bike lane is a bike lane with buffer space that separates bicyclists from motorists. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Buffered bike lane on 4-lane road

Compared to the previous image, this bikeway is placed next to a 4-lane road. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Protected bike lane on 2-lane road

A protected bike lane is an exclusive bike lane that physically separates bicyclists from motorists. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Multi-use trail

A multi-use trail is a dedicated path for bicyclists and pedestrians that is completely separate from the road. Please mark your reaction to **each** statement below:

Bicycling on a trail like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a trail like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

<VERSION 2>

Sharrows on road with parking

Sharrows ("share arrows") show that motorists and bicyclists will be sharing the road. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Bike lane on road without parking

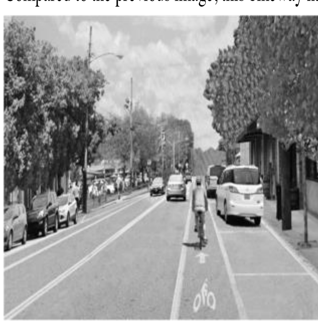
A bike lane is a dedicated lane for bicycling, separated with pavement markings only. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Bike lane on road with parking

Compared to the previous image, this bikeway has parked cars on the right side of the bike lane. Please mark your reaction to **each** statement below:



Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Buffered bike lane on road without parking

A buffered bike lane is a bike lane with buffer space that separates bicyclists from motorists. Please mark your reaction to **each** statement below:

Bicycling on a road like this is ...	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Buffered bike lane on road with parking

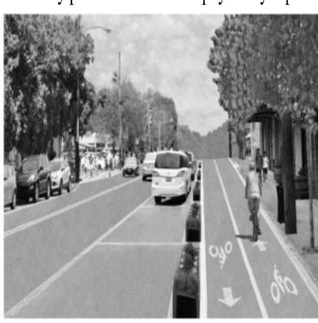
Compared to the previous image, this bikeway has parked cars on the right side of the buffered bike lane. Please mark your reaction to **each** statement below:

Bicycling on a road like this is ...	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Two-way protected bike lanes on road with parking

Two-way protected bike lanes physically separate bicyclists (coming from both directions) from motorists. Please mark your reaction to **each** statement below:



Bicycling on a road like this is ...	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

<VERSION 3>

Sharrows on 4-lane road

Sharrows ("share arrows") show that motorists and bicyclists will be sharing the road. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Bike lane on 2-lane road

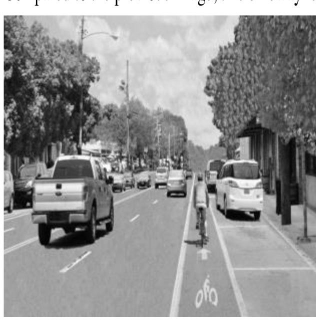
A bike lane is a dedicated lane for bicycling, separated with pavement markings only. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Bike lane on 4-lane road

Compared to the previous image, this bikeway is placed next to a 4-lane road. Please mark your reaction to **each** statement below:



Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Buffered bike lane on 4-lane road

A buffered bike lane is a bike lane with buffer space that separates bicyclists from motorists. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Protected bike lane on 4-lane road

A protected bike lane is an exclusive bike lane that physically separates bicyclists from motorists. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Multi-use trail

A multi-use trail is a dedicated path for bicyclists and pedestrians that is completely separate from the road. Please mark your reaction to **each** statement below:

Bicycling on a trail like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a trail like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

<VERSION 4>

Sharrows on road without parking

Sharrows (“share arrows”) show that motorists and bicyclists will be sharing the road. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I’d try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Bike lane on road without parking

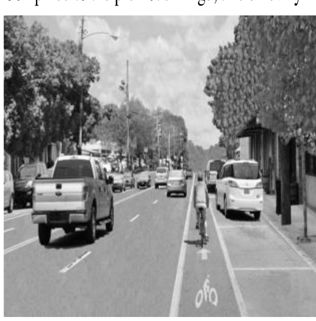
A bike lane is a dedicated lane for bicycling, separated with pavement markings only. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I’d try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Bike lane on road with parking

Compared to the previous image, this bikeway has parked cars on the right side of the bike lane. Please mark your reaction to **each** statement below:



Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I’d try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Buffered bike lane on road without parking

A buffered bike lane is a bike lane with buffer space that separates bicyclists from motorists. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Two-way protected bike lanes on road without parking

Two-way protected bike lanes physically separate bicyclists (coming from both directions) from motorists. Please mark your reaction to **each** statement below:

Bicycling on a road like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a road like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Multi-use trail

A multi-use trail is a dedicated path for bicyclists and pedestrians that is completely separate from the road. Please mark your reaction to **each** statement below:

Bicycling on a trail like this is …	*Completely disagree*	*Disagree*	*Neutral*	*Agree*	*Completely agree*
Comfortable	☐	☐	☐	☐	☐
Safe	☐	☐	☐	☐	☐
Something I'd try	☐	☐	☐	☐	☐

How often have you bicycled on a trail like this? ☐ Never ☐ Sometimes ☐ Often ☐ Not sure

Part E: Your Bicycling Experience

Bicycling is one activity that is gaining more attention, and new bikeways are being installed in many cities. Whether you love it, hate it, or don't care – we're interested in your opinions about bicycling.

1. How would you rate your ability to ride a bicycle? Please indicate your confidence level, regardless of whether it is practical or desirable for you to ride a bicycle nowadays.

   ☐ I cannot ride a bike at all → Please go to **question 4 below**.
   ☐ I can ride a bike, but I am not very confident doing so
   ☐ I am somewhat confident riding a bike
   ☐ I am very confident riding a bike

2. On average, how many miles do you ride a bicycle… ☐ I don't ride a bicycle much / ever

   … for completely **recreational** purposes? ______ miles per **week** ***OR*** ______ miles per **month**

   … for **practical** purposes
   (e.g., to go to work / school, to the store)? ______ miles per **week** ***OR*** ______ miles per **month**

3. Regardless of how you *currently* get there, which of the following factors make it more difficult for you to travel to **work / school** by bicycling? Place a mark (×) at the appropriate place on the scale for each statement below:

	Does not limit ⟺ *Absolutely prevents*	*Does not apply*
The location is too far to be reached by bicycle	|———|———|———|———|	☐
Weather (e.g., rain, heat, cold)	|———|———|———|———|	☐
It is too slow	|———|———|———|———|	☐
It takes too much physical effort	|———|———|———|———|	☐
Safety / security concerns (e.g., traffic, accidents)	|———|———|———|———|	☐
Need to make multiple trips	|———|———|———|———|	☐
Negative effect on appearance (e.g., sweat, hair)	|———|———|———|———|	☐
Difficult to carry bags/heavy packages with me	|———|———|———|———|	☐
Difficult to travel with children	|———|———|———|———|	☐
Other (please specify): ______________________	|———|———|———|———|	☐

4. When it comes to bicycling, what are your experiences and future choices with respect to these activities? Please check the **single most appropriate answer** for **each** of the five activities below:

	*I **do** it now*		*I've **done** it*		*I've **never done** it*	
	*& **might continue***	*& **won't continue***	*& **might do** it again*	*& **won't do** it again*	*& **might do** it*	*& **won't do** it*
Bicycling to work / school	☐	☐	☐	☐	☐	☐
Bicycling to go other places	☐	☐	☐	☐	☐	☐
Bicycling for fun / exercise	☐	☐	☐	☐	☐	☐
Bicycling in bad weather	☐	☐	☐	☐	☐	☐
Using bikeshare services	☐	☐	☐	☐	☐	☐

Part F: Some Background about Yourself

This is the last section of the survey. We're almost done! To help us know you a little bit better, we'd like to ask you a few background questions.

1. How old were you on January 1, 2016? _______ years old

2. Where did you grow up? Please indicate the single US state or territory, or foreign country, where you lived for the longest period of time as a child / teenager. ___________________

3. Overall, how would you describe the area where you were raised?

   ☐ Small town/ rural
   ☐ Suburban
   ☐ Core of a small urban area (e.g., population less than 1 million)
   ☐ Core of a large urban area (e.g., population over 1 million)

4. What is your gender identity?

   ☐ Female
   ☐ Male
   ☐ Prefer not to answer
   ☐ Other (please specify):__________

5. Would you describe yourself as… (please check all that apply)

   ☐ American Indian/Native American
   ☐ Asian/Pacific Islander
   ☐ Black/African American
   ☐ Hispanic/Latino
   ☐ White/Caucasian
   ☐ Prefer not to answer
   ☐ Other (please specify): __________

6. Do you have a driver's license? ☐ Yes ☐ No

7. Are you a current student? ☐ Yes, full-time ☐ Yes, part-time ☐ No

8. What is your educational background? Please check the **highest level attained**.

   ☐ Some grade / some high school
   ☐ High school / GED
   ☐ Some college / technical school
   ☐ Associate's degree
   ☐ Bachelor's degree
   ☐ Graduate degree (e.g., MS, PhD, MBA)
   ☐ Professional degree (e.g., JD, MD, DDS)
   ☐ Prefer not to answer

9. Which statements describe your current employment situation? Please check all that apply:

   ☐ I work full-time
   ☐ I work part-time
   ☐ I have two or more jobs
   ☐ I am a homemaker/ unpaid caregiver
   ☐ I do not work
   → Please go to the **next page**.

10. Which option best describes your main occupation?

    ☐ Professional/technical
    ☐ Manager/administrator
    ☐ Sales/marketing
    ☐ Production/construction
    ☐ Service/repair
    ☐ Clerical/administrative support
    ☐ Other (please specify): ________________

11. On average, **how many hours** in a week do you work **for pay**? _______ hours per week

For the following questions, please remember that by **“household”** we mean, “people who live together and share at least some financial resources” (ordinary housemates/ roommates are usually **not** considered members of the same household).

12. **Including yourself**, how many people live in your household? _____ people

13. **Including yourself**, how many people in your household fall into **each** of the age groups listed below? If there is no one in a particular age group, please respond with zero (“0”) for that age group.

    _____ persons under 6 years old
    _____ persons 6-12
    _____ persons 13-17
    _____ persons 18-26
    _____ persons 27-34
    _____ persons 35-50
    _____ persons 51-65
    _____ persons 66-75
    _____ persons over the age of 75
    ☐ Prefer not to answer

14. **Including yourself**, how many people in your household hold a driver’s license? _____ people

15. How many motorized vehicles (e.g., cars, vans, motorcycles) does your household have? _____ vehicles

16. How many bicycles does your household have? If none, please write “0”. _____ bicycles

17. Please check the category that contains your approximate annual **household income** before taxes:

    ☐ $15,000 or less
    ☐ $15,001 to $30,000
    ☐ $30,001 to $50,000
    ☐ $50,001 to $75,000
    ☐ $75,001 to $100,000
    ☐ $100,001 to $125,000
    ☐ More than $125,000
    ☐ Prefer not to answer

18. In 2016 and 2017 your community may experience changes in transportation, and it is important for us to know your opinions on these changes. To help us reach you for the **follow-up survey next year**, it would be useful to have your email address if you have one. In addition, if you are willing to be contacted in case we have any questions about your survey, we would appreciate having your phone number. All of this information is kept completely confidential, and will never be used for any other purpose.

    Email: ______________________________ Phone: (______) ______–________
    area code

Thank you for your time!

We welcome any additional comments you may have regarding transportation in your community. Please write them in the space below, and on additional sheets of paper if needed.

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